NASA Technical Memorandum 108523
Volume I

The Microgravity Research Experiments (MICREX) Data Base

C.A. Winter
Marshall Space Flight Center • MSFC, Alabama

J.C. Jones
University of Alabama in Huntsville • Huntsville, Alabama

National Aeronautics and Space Administration
Marshall Space Flight Center • MSFC, Alabama 35812

November 1996

Acknowledgments

The NASA Marshall Space Flight Center Microgravity Research Experiments (MICREX) data base has been under the sponsorship of two NASA Headquarters' divisions: the Microgravity Science and Applications Division (MSAD) and the Office of Commercial Programs (OCP). The creation and upkeep of the data base (and completion of this document) would not have been possible if it had not been for the vision and efforts of the following personnel: Gary Martin/NASA Headquarters, Charles Schafer/MSFC, EP13, Charles Baugher/MSFC, ES71, Tim Baldridge/MSFC, ES94, Fred Leslie/MSFC, ES71, Ken Taylor (formerly MSFC/PS05), Tommy Bannister (formerly the Center for Space and Advanced Technology (CSAT)), Randall Stanley (formerly CSAT), Kervin Evans (formerly MSFC/ES42), Anthony Doucette (formerly Wyle Laboratories), George Fichtl (formerly MSFC/JA81), Robert Snyder/MSFC, ES71, and Bob Naumann (formerly MSFC/ES71). Technical editing of this document was performed by Tauna Moorehead (formerly MSFC/ES01) and Judy Maples (DPTI). Michael McMurray (Management Services Incorporated) assisted with the preparation of the figures.

Table of Contents

Volume 1
Section 1: Introduction 1
Section 2: Entire Experiment Listing 135
Section 3: Indexes 187
Index A: Key Words A–1
Index B: Investigators B–1
Index C: Payload Type C–1
Index D: Processing Facility/Evaluated Equipment D–1
Index E: Sample Materials E–1
Index F: Container Materials F–1
Index G: Mission G–1

Volume 2
Experiment Listing (Chapters 1–11) 1
Chapter 1: Biotechnology 1–1
Chapter 2: Capillarity 2–1
Chapter 3: Combustion Sciences 3–1
Chapter 4: Composites With Gases 4–1
Chapter 5: Composites With Solid Particles 5–1
Chapter 6: Containerless Processing 6–1
Chapter 7: Critical Point Phenomena 7–1
Chapter 8: Crystal Growth From Solution 8–1
Chapter 9: Crystal Growth From the Melt 9–1
Chapter 10: Crystal Growth From Vapor 10–1
Chapter 11: Diffusion 11–1

Volume 3
Experiment Listing (Chapters 12–18) 1
Chapter 12: Fluid Physics 12–1
Chapter 13: Liquid Phase Sintering 13–1
Chapter 14: Metals and Alloys 14–1
Chapter 15: Physical Chemistry/Phase Transition 15–1
Chapter 16: Protein Crystal Growth 16–1

Volume 4
Chapter 17: Systems Exhibiting a Miscibility Gap 17–1
Chapter 18: Technological Experiments 18–1

*Note: The seven indexes contained in Volume 1 (Indexes A to G) can be used to quickly identify critical information detailed throughout Volumes 2, 3, and 4. Information on how to use the indexes can be found in Volume 1 on page 71.

Page

2. Recent Experimentation Related to the Study of Beneficial Flows.................. 13
   A. Initial U.S. Materials Processing Experimentation on the Aerobee and Black-Brant Sounding Rockets............. 14
   B. The U.S. Space Processing Application Research (SPAR) Program.................. 15
      B1. The SPAR Program Initiation and Experimental Emphasis............. 15
      B2. The SPAR Vehicle, Launch, and Performance...................... 16
   C. The Japanese TT-500A Sounding Rocket Program........................... 17
      C1. The TT-500A Program Initiation and Experimental Emphasis......... 17
      C2. The TT-500A Vehicle, Launch, and Performance...................... 17
   D. The German TEXUS Sounding Rocket Program................................. 19
      D1. The TEXUS Program Initiation and Experimental Emphasis............. 19
      D2. The TEXUS Vehicle, Launch, and Performance...................... 19
   E. The Swedish MASER Sounding Rocket Program................................. 22
      E1. The MASER Program Initiation and Experimental Emphasis............. 22
      E2. The MASER Vehicle, Launch and Performance...................... 22
   F. The U.S. Consort Program................. 23
      F1. The Consort Program Initiation and Experimental Emphasis............. 23
      F2. The Consort Vehicle, Launch and Performance...................... 23
   G. The U.S. Joust Program.................. 24
   H. Other Current Carriers.................. 25

IV. <u>Early Spacecraft Reduced-Gravity Experimental Facilities</u>............................. 27
   1. The U.S. Mercury Program....................... 27
   2. The U.S. Apollo Program........................ 27
   3. The U.S. Skylab Program........................ 28
   4. The Apollo Soyuz Test Project.................. 31

Page

V. The Space Transportation System (STS) Employed as a Reduced-Gravity Experimental Facility 33
1. The Shuttle Vehicle.......................... 33
2. Experiment Selection Procedure................. 33
A. Solicited and Unsolicited Proposals....... 33
B. The Shuttle Student Involvement Project... 34
3. Experiment Configuration...................... 35
A. Experiments on the Middeck................ 35
B. Experiments in the Payload Bay............ 36
4. Shuttle Experiment Carriers Which Have Housed Fluids and Materials Processing Experiments in the Payload Bay................. 36
A. Pressurized Spacelab Modules.............. 36
B. Small Self-Contained Payloads: Getaway Special Canisters (GAS Cans) MAUS and Hitchhikers...................... 37
C. Free-Flying Satellites Deployed From the Shuttle.............................. 39
C1. The Shuttle Pallet Satellite (SPAS)............................. 39
C2. The Long Duration Exposure Facility (LDEF)............................. 40
D. NASA Office of Space Science and Applications Payload (OSTA-2)............. 41
D1. The Materials Experiment Assembly (MEA).............................. 41
D2. MAUS................................ 42
E. MEA-A2.................................... 42
F. The Materials Science Laboratory (MSL) and the United States Microgravity Payload (USMP)........................... 43
G. Other Current Carriers.................... 44

VI. Creating a Low-Gravity Fluids and Materials Processing Experiments Data Base
1. Creation of a Data Base to Highlight Low-Gravity Fluid Response.................... 45
2. Creation of a Historical Experimental Record to Serve Scientists World-Wide................. 47
3. Identifying Past Experiments/Limiting the Scope of the Data Base..................... 49
4. Types of Experiments Selected for Data Base Inclusion........................ 50
5. Types of Experiments not Considered for Data Base Inclusion........................ 51
6. Missions Encompassed and Detailed in this Technical Memorandum...................... 52
7. Data Sources.................................. 53

Page

8. Querying Investigators.......................... 54
9. Procuring Documents to Allow Preparation of Experiment Summaries............ 56
10. Preparing Meaningful and Complete Summaries.................................. 56
11. A Second Query to the Investigators............ 58
12. Data Base Format................................ 59
13. Quantity of Data Available in Each Experiment Record............................. 62
14. Categorizing the Experiments Within the Data Base........................... 63
15. Past Requests for Information in the Data Base................................... 63

VII. <u>The Hardcopy Version of the Data Base</u>............... 65
1. Importance of a Hardcopy Version............... 65
2. The Chapters (Categories) of this Technical Memorandum........................... 65
3. Available Indices................................ 71
4. Special Nomenclature/Features in the Data Base.. 72
A. Shuttle Mission Nomenclature............. 72
B. Sample Materials/Container Materials Nomenclature............................... 76
C. Quotes in Experiment-Descriptive Summaries................................ 77
D. Notes in Experiment-Descriptive Summaries................................ 79
E. Brief Notes Following References.......... 81
5. Naming the Data Base............................ 82

VIII. <u>Electronic Manipulation and Access of the Data Base</u>.................................... 83
1. In-House Manipulation of Data (PC Software).... 83
2. World Wide Web Electronic Access to MICREX..... 83
3. Searching Capabilities/Limitations of the MICREX Data Base on the WWW................... 85
4. Possible Additional Networking of the Data/ Possible Enhanced Search Capabilities.......... 86
5. Draft of the Data Base on MSAMS................ 87
6. MICREX Data Availability Via ESA's MGDB........ 87

IX. <u>References</u>... 89

Page

X. Appendix.. 97
CSAT Cover Letter.................................. 99
Wyle Cover Letter.................................. 100
Typical Summary Sent to Investigators.............. 101

XI. Figures.. 107
Figure 1. KC-135 aircraft trajectory[15]............ 109
Figure 2. The 2.2-s drop tower at NASA LeRC[20]...... 110
Figure 3. The 100-m drop tower at NASA MSFC[14]...... 111
Figure 4. The 105-m drop tube at NASA MSFC[30]....... 112
Figure 5. The major components of the Aerobee rocket (flight No. 2)[34]................. 113
Figure 6. The Atlas flight experiment mounted in the passenger pod[37]...................... 114
Figure 7. The experiment pod mounted on the Atlas missile[37]......................... 115
Figure 8. The SPAR 2 rocket configuration[41]........ 116
Figure 9. Flight profile of the SPAR 10[39].......... 117
Figure 10. Major components of the TT-500A rocket[44]................................ 118
Figure 11. Typical TT-500A rocket trajectory[44]..... 119
Figure 12. The payload section of the TEXUS vehicle[52].......................... 120
Figure 13. The MASER 1 payload configuration[55]..... 121
Figure 14. The MASER 1 rocket configuration[54]...... 122
Figure 15. Forward and aft sections of the shuttle middeck[20]........................ 123
Figure 16. Experiment apparatus containers[20]....... 124
Figure 17. Spacelab module with access tunnel[71].... 125
Figure 18. Spacelab long module[71].................. 126
Figure 19. GAS canister[81].......................... 127
Figure 20. The shuttle pallet satellite (SPAS)[84]................................ 128
Figure 21. Elements of the OSTA-2 payload[91]........ 129
Figure 22. The materials experiment assembly (MEA)[91]................................. 129
Figure 23. The materials science laboratory (MSL)[95]................................. 130
Figure 24. The U.S. microgravity payload (USMP) subsystems[96]........................... 131
Figure 25. The USMP-2 experiments mounted on two MPESS's[102]....................... 132
Figure 26. MICREX WWW access via Air Mosaic........ 133

I. Interest in Low-Gravity Fluid Dynamics

Throughout the past four decades, scientists, mathematicians, and engineers have become increasingly interested in reduced-gravity fluid statics and dynamics. As a result of this interest, hundreds of experiments have been performed in a reduced-gravity environment to study the benefits and trials of low-gravity fluid response.

1. Problematic Flow Fields Related to Early Rocket/Spacecraft Design

Much of the initial interest in low-gravity fluid statics and dynamics was generated during the design of early rocket and spacecraft fluids systems. During this time, a significant amount of research was performed to study reduced-gravity liquid/vapor (free-surface) interface behavior. Control of such interfaces was expected to be problematic in many space systems including partially filled propellant tanks, space power systems (evaporators/condensers), and spacecraft life support systems (water storage, vapor ventilation).[1]

Much of the initial research concerning such interfaces was related to the low-gravity behavior of propellants in partially-full fuel tanks.[2] Most of the early experiments related to such systems were initiated to study several aspects of propellant tank fluid management including shape and location of the interface, separation of the liquid and vapor, interface dynamics and equilibrium, and heat transfer.

A multitude of terrestrial-based reduced-gravity experiments were performed which indicated that the static and dynamic behavior of the liquid in spacecraft systems (and the associated liquid heat transfer) would be dependent on (1) a variety of reduced-gravity steady and transient acceleration disturbances (vehicle drag, vehicle motion, crew motion, etc.) and (2) gravity-independent forces.

Early mathematical and experimental analyses of the forces acting on the stored propellant, indicated, for example, that low-gravity fluid systems were dominated by intermolecular or surface tension forces (not inertial forces as in terrestrial fluid systems). It was suspected and later verified that propellants partially filling a container in a reduced-gravity environment (1) assumed a shape that minimized the liquid's surface energy and (2) had a final fluid distribution that was dependent on the wetting nature of the fluid to the container and other factors. This meant that without preventative measures, propellants could not be expected to be distributed at the desired position (e.g., the fuel inlet), and might instead float free within the container or become attached at some point(s) to the container wall.

Because the tanks most often stored the liquid for engine restart operations, the systems had to be designed to insure liquid (not a liquid/vapor combination) was available at the pump inlet. It was recognized that if acceleration and heat transfer perturbations combined with surface tension forces were sufficiently severe to move liquid completely away from the area of the pump inlet, the liquid would have to be recollected at the inlet by acceleration of the vehicle (via ullage rockets) along the thrust axis (before attempting to restart the engine).[1]

Heat transfer conditions were also of great concern. Heat gains during long storage periods were expected to contribute to the production of excess vapor. Thus, experiments related to correct positioning and venting of the vapor were also formulated.

2. Problematic Flow Field Challenges of Today

Although the liquid/vapor problematic flows directly related to early rocket/spacecraft design were addressed, capillary-dominated and problematic/deleterious flow fields still plague and challenge scientists and engineers who must overcome or address similar flows in a variety of applications. Reduced-gravity fluid wetting, fluid flow, fluid configuration, etc., must be predicted, analyzed, and/or accounted for in such areas as (1) modern orbital propellant configuration, (2) orbital propellant transfer, (3) heat pipe technology, (4) liquid bridge formation, (5) water dispensing, (6) firefighting, (7) desired immiscible fluid separation, (8) elimination of free surfaces during contained melting, etc.

3. Beneficial Flow Fields

Although the challenges of problematic reduced-gravity fluid flow have and will continue to challenge engineers, more recent experimental efforts have focused on the expected benefits of low-gravity fluid dynamic flow fields.

Preliminary analyses of equations and boundary conditions governing fluid systems of interest, for example, have indicated that a variety of low-gravity fluid systems should experience a reduction in buoyancy-driven convection, particle sedimentation/buoyancy, and/or hydrostatic pressure. Such reductions, in turn, are expected to produce more favorable flow fields in comparison to their Earth counterparts. In addition to these advantages, containerless processing of materials should be possible in the reduced-gravity environment. Such processing is expected to produce materials without the typical nucleation sites and contamination often attributed to the presence of container walls.[3]

Thus, once spacecraft could attain Earth orbit, and long-duration experimentation looked promising, more and more experiments designed to study the benefits of reduced-gravity fluid flow were formulated and proposed. When further analysis and low-gravity experimentation indicated that the thermal fields, solutal fields, particle distribution, and/or fluid configuration associated with several of these low-gravity fluid systems were expected to be desirable for many materials processing initiatives, scientists and mathematicians anticipated that great advances might be made in an entire realm of materials processing endeavors. These advances were to include not only the production of superior materials in space, but also an improved understanding of fluid processes governing a multitude of materials fluid systems.

4. Low-Gravity Research Related to Proving Flow Theory and Examining Secondary Flows

In addition to improved materials processing endeavors envisioned by scientists, mathematicians have long viewed low-gravity experimentation as an opportunity to further prove/disprove fluid flow theories and to determine the role of fluid processes in fluid systems. In the absence of (or more realistically, the reduction of) gravity-dependent fluid phenomena, flow equations are often simplified to permit examination of the effect of gravity-independent flows on the fluid system. Gravity-independent Marangoni flow, electroosmotic flow, Stefan flow, and Soret diffusion[3] can be studied without interference from gravity-dependent phenomena. This in turn, is expected to lead to increased fluid flow prediction and control. Once the role of each fluid process/parameter is understood, experiments might be better designed to achieve the flow fields desired.

5. Low-Gravity Systems Exhibiting Both Problematic Flow Fields and Beneficial Flow Fields

Analysis has also indicated that several fluid systems would be affected both positively and negatively by reduced-gravity fluid response.[4] In the low-gravity, semicontainerless float-zone melt, for example, the fluid system should be positively affected by (1) a reduction of circulatory buoyancy-driven convection (improving temperature and concentration distributions near the solidifying interface), (2) a reduction of hydrostatic pressure (resulting in the formation of longer, more stable zones), and (3) reduced wall effects (such as contamination and nucleation at the zone wall). On the other hand, the semicontainerless melt may be negatively affected by a second type of convection that may be initiated and sustained by thermal and solutal gradients along the zone free surface. This convection, which is gravity independent, is known as Marangoni convection, and results because fluid elements on the free surface with a low surface tension tend to flow to fluid areas of higher surface tension. Often, the convection produces oscillatory temperature gradients within the reduced gravity system and thus reduces the compositional homogeneity of the processed crystal.

Such Marangoni convection also occurs in ground-based floating zone melts, but in the terrestrial laboratory, buoyancy-driven convection usually masks the underlying contribution of surface-tension-driven effects. Even though the Marangoni flow is problematic, the reduction of the gravity-dependent contributions permits a closer examination of surface-tension forces and their critical role in driving thermal and mass transport within the zone.

II. Ground-Based Reduced-Gravity Experimental Facilities

Terrestrial-based facilities that have been historically employed as low-gravity test beds include (1) aircraft, (2) drop towers, and (3) drop tubes. These facilities, most of which were first utilized during early rocket development, provided users with very short-duration low-gravity environments. All three types of facilities are still employed today and are used to model the trials and benefits of reduced-gravity fluid systems.

As discussed by Naumann[5] and Salzman,[6] "low-gravity" or "reduced-gravity" test beds are produced when an experiment facility is placed in a state of free fall. During the free fall, the force of gravity on the experiment is offset by its linear acceleration during the fall.[6] When ground-based facilities are employed, this period of free fall is very short (typically <30 seconds) and most often comes to an abrupt end (e.g., deceleration of the experimental apparatus in a drop tower). When an orbiting spacecraft in the state of perpetual free fall toward the Earth is employed, "reduced-gravity" periods are very long, and experimentation is completed prior to termination of the "low-gravity" environment.

Although the terrestrial-based facilities offer only minimal reduced-gravity experimental time, there are many benefits associated with such research. For example, because it has been repeatedly demonstrated that the results and/or trends of fluid behavior obtained during terrestrial reduced-gravity experimentation are often verified/extended during later space experimentation, the terrestrial facilities provide a relatively inexpensive test bed at which (1) scientific understanding of many phenomena is advanced, (2) proof-of-concept or precursor experiments can be performed, (3) multiple experiment reconfiguration and retry can be realized, (4) space flight hardware can be evaluated (prior to extended low-gravity operation), (5) less stringent experiment safety requirements can be imposed (compared to manifested space missions), and (6) varying investigations can be performed (without major facility modification).[7,8,9]

1. Aircraft Low-Gravity Test Beds

Once it was mathematically determined that aircraft could fly in parabolic trajectories to produce reduced-gravity conditions, F-94, T-33, F-100, and F-104 fighters were employed by the U.S. Air Force to perform the maneuvers.[10] (It was noted that the F-104B could produce "relatively pure weightlessness for 40 seconds.") During these preliminary studies, the effects of the reduced-gravity environment on the crew and aircraft were observed. Short-term evaluation of crew physiological functions revealed tendencies toward nausea, blood pooling, etc.; evaluation of the aircraft indicated that wing-flap motors and inverters were damaged by engine heat and lack of air circulation during the reduced-gravity period.[10] Although it was desirable that experimental apparatuses also be carried on these flights, available cabin area was limited and most equipment had to be placed on the lap of a crew member (with no interference to aircraft canopy closure or ejection seat operation).[10]

In 1958, a program was defined by the Aeronautical Systems Division of the Air Force to provide a reduced-gravity environment large enough for a man to free float during the maneuvers.[10] A propeller-driven C-131B aircraft that had a larger cabin area for a laboratory was proposed for these studies. These aircraft were modified for reduced-gravity flight (e.g., prevention of propeller overspeeding if oil pressure was lost during the parabola) and by the late 1950's, were employed to typically produce 12- to 15-second, unsteady low-gravity test beds (approximately 10^{-2} g).[10,11] A short time later (1960), the jet-powered KC-135 aircraft (originally flown by the Air Force and then later by NASA), was also employed for the early studies.[10,11,12,13]

Although the aircraft were initially used to examine the response of humans to the low-gravity environment, they were soon employed to study low-gravity fluids response. Some of the first experiments performed on the aircraft were initiated to obtain baseline low-gravity fluid configuration and control data related to propulsion systems.[10,11] Initially, experiments were attached to the floor of the payload bay, but later, apparatuses were allowed to free float unrestrained, with observers intervening only if collisions appeared imminent.[10]

Later research efforts related to problematic flow fields included (1) low-gravity fluid boiling and condensation characteristics, (2) flame and combustion characteristics, (3) fuel configuration in spacecraft reaction and control rockets, and (4) low-gravity propellant manipulation via wetting on metallic screens.[10,11]

Similar aircraft are still employed today for such reduced gravity studies. During the flights, researchers can monitor and reconfigure experiments in real time during/between the trajectories.[14] One of the most popular reduced-gravity airplanes used today is the (modified) Boeing KC-135, flown from Ellington Air Field (Houston, Texas).[15] A typical KC-135 parabolic flight trajectory is illustrated in figure 1 (Reference (15). During the maneuver, the plane climbs rapidly at a 45° angle, slows at the top of the parabola, and finally descends at a 45° angle. The forces of acceleration and deceleration are twice that of normal gravity during the ascent and descent sections of the flight, while the brief time at the top of the parabola produces less than 1 percent of the Earth's gravity.[16] Typically, this up and down (roller-coaster) pattern is repeated several times during the flight. Up to 40 trajectories can be performed in the newer KC-135A during one 3-hour flight, each trajectory providing 25 to 30 seconds of reduced gravity conditions.[7,12,15]

The KC-135 vehicle is equipped to provide electrical power, gas sources (including air and nitrogen), communications equipment (intercom), overboard fluid/gas venting, and photographic coverage.[13,15] Investigators provide experiment hardware and sample materials and determine the in-flight experimental procedure.[17] Typically, an experiment assembly is either bolted to the floor of the aircraft or allowed to float freely about the available volume of the payload area. (Bolted assemblies typically experience 10^{-2} g acceleration levels; freely floating assemblies 10^{-3} g's.)[14]

Today, the KC-135, KC-135A, and the Learjet Model 25 aircraft continue to be employed by NASA[14] to examine a wide variety of scientific endeavors including (1) the evaluation and design of hardware to be flown on extended low-gravity missions, (2) low-gravity fluid transport and fluid interfacial studies, (3) low-gravity heat transfer studies, (4) reduced-gravity gas combustion investigations, (5) containerless processing/studies using acoustic or ultrasonic levitation, (6) low-gravity welding demonstrations, (7) low-gravity melt-crucible interactions, (8) contained directional solidification experiments, etc.[18,19]

2. Drop Towers

The early 15-second aircraft reduced-gravity studies were complimented by even shorter-duration terrestrial drop tower experiments. One of the first drop towers available for such experimentation was at the NASA Lewis Research Center (LeRC). The facility, which had previously been employed at the Center as a fuel distillation tower, was initially used as a low-gravity test facility in the late 1950's and continues to be employed today. Detailed descriptions of the tower can be found in References (6, 7, 14, and 20).

The tower is depicted in figure 2 (Reference (20)). The top of the tower is equipped with an aerodynamic canister (complete with drag shield), into which an experimental package (weighing less than 150 kg) is placed. Once the fluids in the package are stabilized and the research team is ready, the canister is released. As the experimental package/canister free falls approximately 30 m into a 2.1-m deep sand pit below, the experiment package floats freely within the canister.[7,8,21] During the fall, high-speed motion picture cameras are used to record fluid response; thermocouples, pressure transducers, etc., document other relevant data. Deceleration levels at impact vary from approximately 40 to 100 g's for several milliseconds. At impact (and earlier at free-fall initiation) the fluid system experiences a step change in gravity that can produce large transient effects in the fluid system.[20]

Reportedly, over 10,000 test drops have been conducted in the LeRC facility since it was first employed and 1,000 test drops are routinely performed each year (up to 15 drops can be performed in one day).[7,20] Although the tower can provide only 2.2 seconds of reduced-gravity environment (at a gravity level typically less than 10^{-5} g),[14] this level is lower than that attainable in modified jet aircraft flying in parabolic trajectories.[20]

Early drop tower experiments at LeRC were performed to determine how and what factors (contact angle, surface tension, etc.) affect reduced-gravity liquid orientation. The research was then extended to study propellant configuration in partially filled tanks.

The above mentioned LeRC drop tower and other similarly designed drop towers (such as the tower at Marshall Space Flight Center (MSFC)), were eventually employed to perform experiments designed to examine the benefits of reduced-gravity fluid response. For example, in the early 1970's the 100-m (4.2-s) MSFC tower (fig. 3)[14] was first used to perform ground-based experimentation related to low-gravity materials processing.[17,20,22,23] (The tower had originally been used to investigate Saturn V/S-IVB stage orbital propellant behavior.)[24,25] One of the first of these materials experiments was initiated to examine the possibility of containerless processing. During the study, a variety of fluids (mercury, glycerin, and glycerol) were employed to study reduced-gravity (containerless) sphere formation, deployment, and oscillation.[17,22] These studies were complimented by other drop tower experiments designed to demonstrate the feasibility of employing magnetic fields for the positioning and processing of containerless solid-and-liquid materials (i.e., metallic spheres).[17] Other early MSFC drop tower experiments included the rapid cooling and solidification of low-temperature melting immiscible metals such as gallium-bismuth.[5,26] Although the MSFC drop tower is currently not being employed for such studies, other available drop facilities continue to provide reduced-gravity test beds for a variety of experiments. For example, more recently, the LeRC towers (the aforementioned 2.2-s facility and an additional sophisticated 5.18-s (10^{-6} g) vacuum facility)) have been employed to examine many fluid systems including (1) solid fuel flame spread, (2) diffusion flame combustion, (3) droplet combustion, (4) surface tension-driven convection, (5) multiphase/multifluid forced flow through a conduit, etc.[14]

3. Drop Tubes

A drop tube differs from a drop tower in that single, containerless liquid/molten samples (not scale-model experimental packages) are allowed to free fall the length of the tube (fig. 4).[30] Using such a facility, large amounts of undercooling in metals and alloys can be achieved by allowing the sample to free fall without contacting any external surfaces. A furnace (contained within a bell jar) at the top of the tube melts the material of interest and then the drop is released to fall the length of the vertical tube.[29] (Both the bell jar and tube are evacuated to the desired pressure.) The tube can be backfilled to provide for increased cooling of materials. Samples are decelerated and caught by catchers. Using this method, experiment duplication is relatively easy and cost effective (when compared to sounding rocket or manned space flight experimentation).

The original drop tube at MSFC (built in 1976)[30] was 30-m long (10-cm diameter), and provided 2.6 s of reduced-gravity (or free-fall) time.[29] The facility was built after preliminary analyses of Skylab containerless processing experiments indicated that additional reduced-gravity research of uncontained, molten liquid drops was necessary.[27] The first materials examined in the drop facility included niobium and niobium-germanium alloys.

In 1980, a longer tube was built at the Center.[30] This longer tube (105-m (25-cm diameter)) is still employed today and allows 4.6 s of free-fall time.[31] To date, over 5,000 experiment samples have been dropped in the facility and evaluated.[30]

The tube is long enough to solidify a wide range of materials from the melt. Recent research efforts in the tube include the containerless solidification of a number of high and low melting temperature metals and alloys. For example, containerless niobium-platinum samples, which melt at high temperatures and are highly reactive with crucible materials, have recently been undercooled and solidified in the low-gravity facility, illustrating complete solute trapping.[28]

Additional information on the drop tube can be found in Reference (32).

III. Suborbital Sounding Rockets

Longer duration reduced-gravity experimentation was performed on (1) suborbital sounding rockets (beginning in the early 1960's) and (2) pods ejected at a suborbital altitude from the Atlas intercontinental ballistic missile (in the mid 1960's). These early experiments were primarily related to the study of liquid/vapor (free surface) interfaces. Beginning in the 1970's, suborbital rockets were employed to produce 4 to 6 minutes of reduced-gravity for experiments designed to examine the benefits and trials of reduced-gravity materials processing. Since that time, experimental endeavors in such sounding rockets have continued and the rockets have become a popular source of extended-duration, low-gravity research (typically 6 to 7 minutes). Currently, a wide variety of scientific investigations are carried on the vehicles including crystal production, cell fusion, physical chemistry, fluid dynamics, etc.

1. Early Experimentation Related to the Study of Problematic Flows Encountered in Rocket/Spacecraft Design

A. Experiments on the Aerobee Sounding Rocket

Beginning in the 1960's, experiments designed to examine low-gravity liquid behavior and problematic flow fields associated with partially filled propellant tanks were carried in the front end of the Aerobee 150A (suborbital) sounding rocket.[2,33,34,35] Typically, the experimental package included (1) a 9-in spherical scale-model propellant tank partially filled with liquid hydrogen (and configured with heaters and thermocouples), (2) telemetry equipment to transfer thermocouple and other data, and (3) a camera to document liquid/vapor configuration. The major objectives of these missions included (1) subjecting the partially filled dewars to controlled, radiation-heated environments; (2) determining the resulting fluid configuration under reduced gravity conditions; (3) determining the heat transfer between the container wall and employed fluid; and (4) examining the rate of pressure rise in the closed hydrogen dewar.

The major components of the Aerobee rocket (with details of the payload section for flight No. 2) are depicted in figure 5 (Reference (34)). Since the Aerobee was a spin-stabilized vehicle, the experiment was placed on a spin table within the payload section. Although it is not specifically stated in the available references, it appears that the spin table rotated counter-clockwise to the rocket, thus insuring that the dewar and other equipment were maintained at an (effective) zero spin rate during rocket boost.[2,33,34] In addition, the rocket contained helium thrust nozzles that were used to compensate for the anticipated air drag encountered immediately after sustainer burnout and hence to extend the reduced-gravity period. Although not indicated in figure 5, accelerometers were housed in the vehicle to document reduced gravity levels.[33]

The two-stage, solid-propellant Aerobee 150a rockets, which typically carried experimental payloads weighing approximately 300 lb., were launched from Wallops Island, Virginia. Flight sequences for four of the flights are given in References (2, 33, 34, and 35). (It appears that at least 9 such Aerobee flights were realized during the program before its termination.) The major events during flight No. 9 (as detailed in Reference (2)) were described as follows: 53 s after launch, second-stage (sustainer) burnout occurred at an altitude of 110,000 ft. Approximately 30 s later, rocket despin occurred and the trajectory experienced a reduced-gravity environment (10^{-4} g) for approximately 4.5 min. During this time, the trajectory attained a maximum height of 102 mi as it continued its ballistic, free-fall trajectory. Throughout the flight, liquid hydrogen configuration and heat transfer characteristics were recorded.

Although flight No. 9 did not contain a movie camera for the documentation of solid/liquid/vapor configurations, some of the flights were equipped with such equipment. These cameras were housed in a recovery capsule that separated from the remainder of the payload (after approximately 350 s of flight) and parachuted into the Atlantic Ocean. Air and surface craft were employed to search for the capsules.[33] <Note: References (2, 33, 34, and 35) did not detail the recovery procedures (if any) for the rocket/experimental-payload. Reference (36) indicated that the experiment parachuted into the water and was recovered by the U.S. marines.>

B. Experimental Pods attached to the Atlas Intercontinental Ballistic Missile

In the mid 1960's, even longer duration low-gravity experimentation was achieved in experiment pods initially attached to the Atlas intercontinental ballistic missile. The pods, which were ejected from the Atlas at a higher (yet suborbital) altitude than that of the Aerobee sounding rocket, experienced approximately 20 to 30 minutes of reduced-gravity experimental time. Available references did not indicate how many such pod ejection flights were performed before the program was terminated.

Research objectives of experiments contained within a pod were nearly identical to those of the Aerobee. However, while most of the Aerobee research had indicated that the low-gravity time available on the rocket was sufficient to establish steady-state or limiting conditions, the research also indicated that if a low heat flux (25 Btu per hour per square foot) was imposed on the liquid hydrogen dewars, more time was required to reach quasi-equilibrium or limiting conditions (so that time extrapolated predictions could be made).[37]

The Atlas passenger pod experimental hardware was similar to that of the Aerobee hardware, but the pod carried two differing diameter, partially filled subscale propellant tanks. Thus, tank scaling effects related to the study of heat transfer characteristics could be determined.[36]

The experiments were configured in the 8.5-ft. long, 30-in diameter pod with the necessary associated hardware. In addition to the telemetry system and other equipment, the pod contained a mass stabilization system. The system was included to attenuate any acceleration perturbation to the pod that might be imparted by the vehicle or ejection mechanism.[37] (For more information see Reference (37)). Figures 6 and 7 (Reference (37)) illustrate the flight experiment mounted in the passenger pod (fig. 6) and the pod mounted on the Atlas missile (fig. 7).

The Atlas vehicle with its "piggy-back" pod was launched from the Atlantic Missile Range in Florida. A pod flight history was detailed in Reference (37). Fifteen seconds after pod ejection, the mass stabilization system was enabled. During this particular flight, a malfunction of the circuit controlling the stabilization system occurred and as a result, the experiment experienced an acceleration field on the order of 10^{-3} g during the reduced gravity period (8 to 29 min after lift-off). During the flight, measurements of the hydrogen dewar wall temperatures, the liquid hydrogen thermal profiles (and relative positions of the gas ullage), dewar pressures, pod acceleration level, etc., were telemetered to the ground and recorded on magnetic tape (no cameras were available in the pods). No attempt was made to recover the pod itself.

2. Recent Experimentation Related to the Study of Beneficial Flow Fields

Since the early 1970's, scientists and engineers have become increasingly interested in employing the low-gravity environment to achieve beneficial flow fields. This interest escalated in the mid 1970's after extended-duration spacecraft experimentation on Skylab and the Apollo-Soyuz Test Project (ASTP) demonstrated (1) promising materials processing results and (2) intriguing fluid dynamic observations (see pp. 28-31).

A. Initial U.S. Materials Processing Experimentation on the Aerobee and Black-Brant Sounding Rockets

MSFC materials processing experiments were configured on sounding rockets soon after the Apollo 14 mission.

In December 1969, Apollo 14 carried a composite casting (materials processing) experiment designed to produce materials with improved or unique mechanical, electrical, and/or optical properties.[38] During the mission, only 11 of the 14 experiment capsules were processed. In May 1971, a co-investigator of the Apollo experiment (H. Wuenscher of MSFC), visited Goddard Space Flight Center (GSFC) to ask if an unused composite casting experimental capsule (and the associated processing facility) could be placed on a GSFC sounding rocket.[38] (Rockets such as the Aerobee 170A and the Black Brant VC were being tested and evaluated at the time by the engineers at the GSFC Sounding Rocket Division.) It was determined that the experiment hardware could be placed on an Aerobee 170A rocket if the lead ballast that often makes up part of the vehicle payload was removed.[17]

The employed Aerobee 170A, which was composed of a three-fin Aerobee 150A liquid propellant sustainer and a solid propellant Nike booster, was launched specifically by GSFC to evaluate the dispersion characteristics of the vehicle. The secondary (piggyback) materials processing experiment, which flew as planned in a small area of the payload section, was implemented by MSFC engineers to not only process the Apollo sample, but to determine if such rockets were suitable for reduced-gravity research.

The rocket was launched in October 1971 from the U. S. Navy Ordnance and Missile Test Facility (USNOMTF), in White Sands, New Mexico. The rocket reached an altitude of approximately 150 km and experienced a reduced-gravity time of 220 s. The vehicle was equipped with accelerometers, and despun with a yo-yo despin system. (The despin was accomplished by deploying weights on the ends of cables that were attached to the vehicle.)[17]

The piggy-back experiment was designed to investigate the stability of gas bubbles in a plain and fiber-reinforced metal melted and solidified in a reduced-gravity environment.[17] The employed single sample had two distinct halves. The a-half consisted of interconnected gas cells in a fiber-reinforced metal matrix; the b-half consisted of discrete gas bubbles in a plain metal matrix. During the flight, the sample was to be heated such that a phase change from solid to liquid occurred.[38]

Post-flight examination of the sample indicated that the a-half of the sample had not been heated sufficiently to provide meaningful results and that the b-half of the sample experienced only partial melting. It was reported that "In the areas which appeared to have melted, three conditions were noted: some bubbles had disappeared, some bubbles had coalesced, and some bubbles remained in place."[17] References 17 and 38 further detailed the experimental results.

<Note: It appears that an unused Apollo 14 experimental capsule was not employed in the Aerobee experiment as originally planned. Reportedly, the sample processed on the Aerobee 170A was "designed and fabricated for the Apollo 15 'Composite Casting Demonstration'" experiment.[17] (The sample most likely became available when the composite casting experiment was removed from the Apollo 15 manifest.)>

A similar sample was flown on a Black Brant VC sounding rocket in 1972. Again the experiment flew piggy-back on a vehicle that was launched to primarily test and verify the rocket performance. Unfortunately, during flight, the heat shield was not separated from the payload and the experiment was lost.[17]

After the two rocket flights were evaluated, it was concluded[38] that the sounding rockets, equipped with altitude control systems and sufficient payload despin systems, provided a good environment for materials processing experiments.

B. The U.S. Space Processing Application Research (SPAR) Program

B1. The SPAR Program Initiation and Experimental Emphasis

Although flying experiments one-at-a-time (piggy-back) on sounding rocket test flights was relatively inexpensive compared to the cost of purchasing rockets to specifically carry reduced-gravity experiments, there were several advantages to implementing a sounding rocket program dedicated to low-gravity fluids and materials processing research. Among these advantages were (1) an increased payload area available for experimentation and (2) rocket altitude control and despin systems specifically designed to produce the desired reduced-gravity research environment.

The first sounding rocket program dedicated to exploring and developing techniques for processing a variety of materials in a reduced-gravity environment was the SPAR program. The SPAR project was a NASA activity, directed by the Office of Space and Terrestrial Applications (OSTA). (OSTA was later renamed the Office of Space Science and Applications (OSSA).) The program was initiated to permit development and testing of reduced-gravity experimental concepts at a time when manned spaceflight opportunities were not available (between the ASTP mission and the U.S. space shuttle missions).[5] Reportedly, SPAR experimentation was performed to help define future shuttle fluids and materials processing investigations.

The SPAR rockets, which were first launched in 1975, were capable of providing 4 to 6 minutes of reduced-gravity experimental time. During its brief history (10 flights between 1975 and 1983), SPAR carried approximately 70 experiments (typically 5 to 8 experiments per flight). Approximately 50 of the SPAR experiments were related to fluids or materials processing research and included (1) the directional solidification of magnetic composites, (2) containerless processing technology (liquid drop stability and manipulation), (3) alloy solidification, (4) liquid mixing due to spacecraft motion, (5) dispersion of immiscible materials, (6) multiphase particle interaction, (7) closed-cell metal foam production, and (8) dispersion strengthening composites.[39]

B2. The SPAR Vehicle, Launch and Performance

The program typically employed single-stage, solid-propellant Black Brant VC rockets (SPAR flights 1 to 5, and flight 10). The rockets were powerful enough to place a science payload of approximately 400 lb in a reduced-gravity environment (10^{-4} g) for 5 minutes.[39,40] The SPAR 2 (designated as SPAR II) total rocket configuration is presented in figure 8 (Reference (41)).

A Black Brant VC rocket with a Nike boost was employed to accommodate heavier payloads or to achieve reduced-gravity periods of longer duration (SPAR flights 6 to 9).

The payload section of the SPAR included (1) interchangeable experiment modules, (2) a measurement module (housing tri-axial accelerometers), (3) an experiment support module, (4) a telemetry system, (5) a despin system, (6) a rate and control system, (7) a payload destruct system, and (8) a payload recovery system.[9]

The vehicles were launched from White Sands Missile Range, New Mexico. The flight profile of SPAR 10 is detailed in figure 9 (Reference (39)). During the SPAR 10 mission, the employed spin-stabilized rocket attained an altitude of approximately 60 km before the rocket propellant was exhausted. At this altitude, the rocket was despun and the payload separated from the rocket.[39] After separation, a rate control system insured that residual rotational rates were attenuated. During the following unpowered coast phase, the payload experienced approximately 5 min of reduced gravity (typically 10^{-4} g; apogee approximately

180 km). After the conclusion of the low-gravity coast phase, a parachute system was deployed, and the payload was retrieved on land by helicopter (82 km down range).[39]

C. The Japanese TT-500A Sounding Rocket Program

C1. The TT-500A Program Initiation and Experimental Emphasis

A sounding rocket program dedicated to studying reduced-gravity materials processing was initiated in Japan in 1980. The effort, known as the TT-500A sounding rocket program, was developed by the National Space Development Agency of Japan (NASDA) and continued for 3 years. During this time, six rockets were launched, each typically carrying 2 to 4 electric furnaces within its payload section for the processing of metallic alloys or semiconductors (flights No. 1 to 5).[42] Flight No. 5 also housed a halogen lamp system experiment; flight No. 6 evaluated (1) an electric furnace (composite fabrication), (2) an image furnace (composite fabrication) and (3) an electric furnace with an acoustic mixer (immiscible alloy production). The program was terminated after six launches due to budgetary limitations.[43]

The TT-500A program had two major goals, both of which were related to Japan's (then future) experiments on the U.S. space shuttle.[44] (These future experiments were known as the First Materials Processing Test (FMPT) and were later flown on the shuttle during STS Spacelab-J (September 1992)). The first goal was to provide a reduced-gravity test bed for some of the FMPT materials processing experimental concepts/hardware. The second goal was to ensure functional coordination between Japanese ground-based facilities that would later be used during the U.S. shuttle flight (the Tanegashima Space Center and the Ogasawara Down-Range Station).

C2. The TT-500A Vehicle, Launch and Performance

Prior to the initiation of the TT-500A materials processing program in 1980, there were seven test flights of the TT-500 rocket to verify its performance. The numbering sequence of the materials processing flights were therefore TT-500A 8 (flight No. 1), TT-500A 9 (flight No. 2), etc.[45] TT stands for "Tracking Test," "500" represents the rocket diameter (500 mm) and the "A" indicated that the rocket was improved from the original TT-500 rocket (to include installation of experimental devices, attitude control systems, and a recovery system).[42,43]

The vehicle was designed to carry a materials processing system with a maximum mass of 135 kg (330 kg total payload weight).[42,46] The small, two-stage, solid-propellant rocket weighed 2.35 tons and stood 10.5-m high (including the 2.7-m payload section).[44,47] The major components of the vehicle are depicted in figure 10 (Reference (44)).

The rockets were launched from the Takesaki launch site on Tanegashima Island. A nominal rocket trajectory is depicted in figure 11 (Reference (44)). Typically, second-stage burn-out occurred at 50 s after launch and payload separation followed shortly thereafter. The payload section was then despun by a yo-yo despinner (reducing the payload section spin rate to almost zero) and then a gas jet system insured that roll, pitch and yaw spin rates were less than 0.2 deg/s.[42,46,47] Shortly thereafter, the experiment was initiated and experienced reduced gravity* for approximately 6 to 7 min.[43,44,48] During this time, the payload section attained a maximum height of 320 km and continued its trajectory path to approximately 100 km (experiment termination). Parachute deployment was initiated at approximately 6 km, followed by splash down recovery (approximately 500 km offshore from Tanegashima island).[43,44] Although the payload section was equipped with a float to permit it to stay above water, the section could not be retrieved prior to sinking after flights No. 2 and 3 (the floating system malfunctioned after flight No. 2 and the main parachute was not activated during flight No. 3).[42,43,47]

* (Except for flight No. 1, which experienced a gravity level of 10^{-2} g due to a despin difficulty, the rest of the flights attained a gravity level of 10^{-4} g.)[47]

D. The German TEXUS Sounding Rocket Program

D1. The TEXUS Program Initiation and Experimental Emphasis

In 1976, the West German government, in cooperation with Sweden, initiated a sounding rocket program dedicated to studying reduced-gravity materials processing. The effort, known as the TEXUS program (Technologische EXperimente Unter Schwerelosigkeit, or in English, Technological Experiments under Microgravity Conditions) is still operational.[49]

At the initiation of the program, the West German Minister for Research and Technology charged the then named Deutsche Forschungs und Versuchsanstalt für Luft- und Raumfahrt (DFVLR) (German Research and Development Institute for Aviation and Space Travel) with managing the program.[50] <Note: the DFVLR is now called the Deutsche Forschunsanstalt für Luft und Raumfahrt (DLR).> The initial objective of the TEXUS program was to prepare for future ESA Spacelab utilization by flight proving experiments/hardware in advance. (The European Space Agency (ESA) had agreed to develop and build Spacelab for the U.S. shuttle program.) However, after only a few TEXUS flights, it became clear that valuable knowledge was gained during rocket experimentation that went beyond preparing for long-duration missions such as Spacelab. For example, like the U.S. SPAR experiments, TEXUS rocket experimentation (1) not only significantly illustrated the effects of the reduced-gravity environment on materials systems, but (2) also proved to be relatively inexpensive and less restrictive (when compared to spacecraft experimentation).

Thus, TEXUS soon became an independent experiment carrier for investigators wishing to carry out reduced-gravity research activities.[51] Although the program was originally earmarked for experiments by domestic users, flight opportunities are currently available to scientists from other countries, especially countries which are members of ESA. Typically, it takes at least 1 year to (1) design and build the flight hardware, (2) install the hardware in the rocket module, (3) perform tests to guarantee technical functional capacities, (4) transport the rocket to the launch pad, and (5) complete final assembly of the experiment modules in the vehicle.[51]

D2. The TEXUS Vehicle, Launch and Performance

The TEXUS program employs a two-stage Skylark 7 high-altitude rocket (apogee approximately 250 km).[51] The rockets, which can carry a payload of 350 kg, are launched from Esrange sounding rocket range in Kiruna, Northern Sweden.

The payload section of the vehicle (fig. 12)[52] typically includes five or six 400-mm diameter interchangeable experiment modules called TEM's (or TEXUS Experiment Modules). The TEM's house a variety of experimental equipment (e.g., furnaces, etc.) which have been re-used (with some refurbishment/improvement) throughout the TEXUS program. (Sweden, which provides the launch site facilities for the rocket, also developed an experimental module to specifically house Swedish experiments on TEXUS.) Each module has its own power supply, data recording unit, and experiment controls.

The remainder of the payload section includes an instrumentation module (with accelerometers and telemetry), a yo-yo despin system, a rate and control system, and a parachute recovery system.[9,51]

After launch, and first and second-stage burnout, the yo-yo despin system is enabled (weights suspended from cables) to reduce the rocket stabilizing rotation. Shortly thereafter, the payload section is separated from the rocket and the reduced-gravity phase (10^{-4} g) is attained and continues for approximately 6 min. <Note: Reference (53) indicated that the payload is first separated from the booster and then despun.> During this reduced-gravity phase, the payload section follows a parabolic trajectory attaining a maximum height of approximately 250 km.[53] The parachute recovery system lands the payload approximately 50 km from the launch pad. The payload section is retrieved by helicopter (with the help of a radio direction transmitter) typically within 1 hour of payload impact.[51]

At the beginning of the program, approximately one to two rockets were launched per year. Recently, four rockets have been flown per year (two in the spring and two in the fall). Of the 20 TEXUS launches detailed in this memorandum (see table 1), rocket or rocket-despin failure occurred during three of the missions (TEXUS 3a, TEXUS 15, and TEXUS 16) and a higher than desired low-gravity environment was experienced during one of the missions (TEXUS 14a).

Although over 30 TEXUS missions have been flown to date, only the experiments performed during the first 20 TEXUS missions are included in this document. (The later missions were beyond the cutoff date for inclusion in this document.)

Table 1
TEXUS flights detailed in this technical memorandum

Flight No.	TEXUS Mission	Date
1	TEXUS 1	December 1977
2	TEXUS 2	November 1978
3	TEXUS 3a	April 1980 (Rocket Despin Failure)
4	TEXUS 3b	April 1981
5	TEXUS 4	May 1981
6	TEXUS 5	May 1982
7	TEXUS 6	May 1982
8	TEXUS 7	May 1983
9	TEXUS 8	May 1983
10	TEXUS 9	May 1984
11	TEXUS 10	May 1984
12	TEXUS 11	April 1985
13	TEXUS 12	April 1985
14	TEXUS 13	April 1986
15	TEXUS 14a	May 1986 (Wobbling Motion, Low-G not Attained)
16	TEXUS 14b	May 1987
17	TEXUS 15	May 1987 (Rocket Failure)
18	TEXUS 16	November 1987 (Rocket System Malfunction)
19	TEXUS 17	May 1988
20	TEXUS 18	May 1988

E. The Swedish MASER Sounding Rocket Program

E1. The MASER Program Initiation and Initial Experimental Emphasis

In response to an increasing demand for fluids and materials processing reduced-gravity flight opportunities, a sounding rocket program was initiated in Sweden in 1987 (Reference (54)). The effort, known as the MAterials Science Experiment Rocket (MASER), is still operational today and is managed by the Swedish Space Corporation (SSC). The MASER payloads attain a reduced-gravity level (approximately 10^{-4} g) for 6 to 7 minutes.

Although at least four MASER flights have been flown to date, only the experiments flown on the first two flights have been included in this document. MASER 1 was launched on March 19, 1987, and MASER 2 was launched on February 29, 1988. (The later flights were beyond the mission cutoff date for this publication.) MASER 1 and 2 carried a variety of experimental modules including (1) a fluid science module to study thermocapillary drop motion and three-dimensional Marangoni convection, (2) a mirror furnace module to investigate meniscus stability and coalescence processes in immiscible alloys, (3) a crystal growth furnace module to study semi-confined Bridgman growth of Ga doped Ge, and (4) a gradient furnace module to examine the processing of metallic alloys.

E2. The MASER Vehicle, Launch and Performance

The vehicle was designed to carry a payload with a maximum mass of 390 kg. Four to six 17-in experiment modules and other various subsystems can be configured within the modular payload area. The MASER 1 payload configuration is depicted in figure 13 (Reference (55)). In addition to the experiment modules, the payload section includes (1) a constant lateral attitude S19 guidance control system (which maintains the vehicle in the launch direction during the 18 s following lift-off), (2) a yo-yo despin system (which reduces the stabilizing spin after the launch phase), (3) a service module (which contains a variety of equipment including the telemetry system, radar transponder, batteries, power regulators, tri-axial accelerometer unit, etc.), (4) a rate control system (RCS) (to reduce angular rates in the payload during the reduced-gravity phase), and (5) a recovery module (a parachute/heat-shield/beacon-transmitter system enabling a ground impact with recovery by helicopter typically less than 2 hours after launch).[54]

The rockets are launched from the Esrange sounding rocket range in Northern Sweden. The vehicle, designated Black Brant IX B, has two stages. The first stage is a three-fin Terrier booster, the second, is a three- or four-fin Black Brant VB sustainer (figure 14; Reference (54)). (MASER 1 employed a three-fin sustainer, MASER 2 employed a four-fin sustainer.)

The major events in the MASER 1 and MASER 2 flight sequences were reported in References (54 and 56). It appears that the major difference in the two flights was that payload despin occurred after separation (from the second stage) during MASER 1, while despin occurred prior to payload separation (from the second stage) during MASER 2. The MASER 2 flight sequence was reported as follows: After launch and first- and second-stage burnout, rocket despin occurred (launch plus 55 s). Five seconds later, the second stage separated from the payload section and the rate and control system was enabled. Shortly thereafter (launch plus 73 s), the reduced-gravity phase (10^{-4} g) was achieved and continued until launch plus 512 s (apogee 316 km). Approximately 110 s after the end of the reduced-gravity phase, the recovery sequence was initiated (heat shield plus initial chute deployment). Thirty-five seconds later (665 s after launch) payload impact was recorded.

F. The U.S. Consort Program

F1. The Consort Program Initiation and Experimental Emphasis

A sounding rocket program designed to support the goals of the NASA Office of Commercial Programs was initiated in 1988. The effort, which was managed by the Consortium for Materials Development in Space (headquartered at the University of Alabama in Huntsville), was called Consort. The 5-year program had two major objectives: (1) to perform materials and biotechnology investigations having commercial value and (2) to stimulate the commercial rocket industry in the U.S.[57]

F2. The Consort Vehicle, Launch and Performance

The payload section of the Consort had three cylindrical compartments assembled end-to-end. An individual compartment could either be vented or sealed (to maintain atmospheric pressure) during the flight.[57] Some compartments had access doors to allow installation of equipment/samples late in the launch sequence. Although the payload section was similar to the size and length of the SPAR payload sections, the Consort vehicle could either (1) carry a heavier payload than the earlier SPAR vehicle or (2) provide a longer reduced-gravity phase than SPAR.[57]

Consort employed a two-stage, Starfire I rocket. The spin stabilized vehicle, which was configured with a Thiokol TX 664 booster motor and a Bristol Aerospace Black Brant VC sustainer motor, was launched from White Sands Missile Range, New Mexico.[57] The vehicle was equipped with systems to provide guidance, telemetry, acceleration measurement, rotation rate control, and parachute recovery.

During a typical Consort flight, first- and second-stage burnout were followed by vehicle despin and then payload separation.[58] During the subsequent unpowered flight of the trajectory, approximately 6 to 8 min of reduced gravity (approximately 10^{-5} g) was realized. During this time, the trajectory achieved an apogee of approximately 300 km. A short time after the reduced-gravity phase, the payload section parachuted to the ground (approximately 100 km downrange).[57]

The first Consort mission was launched on March 29, 1989. This historic mission carried the first low-gravity materials processing payload ever launched in the U.S. on a commercially licensed rocket.[59] The vehicle carried a variety of experimental investigations including: powdered metal sintering, electrodeposition and codeposition, polymer demixing, polymer foam production, etc. During the entire Consort program, a total of six rockets were launched.[60]

G. The U.S. Joust Program

Another series of suborbital missions called the Joust Program (initiated by the NASA Office of Commercial Programs and managed by the Consortium for Materials Development in Space) was also planned.[57] For comparable payload masses, the Joust vehicle (which employed a Prospector rocket) was to produce almost twice as much reduced-gravity time (13 to 15 min) as the Consort vehicle. For a similar payload mass (250 kg), the vehicle was to attain a maximum altitude of 815 km (requiring an ablative heat shield for re-entry from this altitude). Although Joust 1 was launched in June 1991 from the Eastern Space and Missiles Center, (Patrick Air Force Base, Florida), the vehicle experienced a rocket failure in the aft skirt.[60] The Joust program was not further pursued.

H. Other Current Carriers

Recently (post 1989), additional carriers have been employed to place experiments in suborbital flight. These carriers include:

(1) The German MAXUS Sounding Rocket Program (1991-present)
(2) The Japanese TR-1A Sounding Rocket Program (1991-present)
(3) The Canadian Microgravity Rocket (CSAR) (1992-present)

Detailed descriptions of these carriers are not presented in this document because this hardcopy version of the data does not contain summaries of these more recent experiments.

IV. Early Spacecraft Reduced-Gravity Experimental Facilities (1962-1975)

The manned spacecraft program provided the first opportunities for extended duration low-gravity fluids and materials processing experimentation (e.g., >20 min). The Skylab space station, which was manned by three different crews for 4, 8, and 12 weeks, respectively, provided the longest manned experimental opportunities (days, weeks). Other manned vehicles (Apollo-Soyuz Test Project and the space shuttle) provided hours or even several days for some experiments.

1. The U.S. Mercury Program

The first (manned-spacecraft) experimental payload designed to examine reduced-gravity fluid response was carried into space during the Mercury program. The experiment, which was an extension of research initiated in the ground-based LeRC drop tower, was designed to examine fluid flow in a closed container.

While drop tower experiments had illustrated that correct placement of specially-designed baffles within a container could result in the predictable positioning of the liquid vapor interface,[21,61] the terrestrial experiments could not sufficiently illustrate if the surface-tension baffling would (1) maintain control of the liquid vapor interface during acceleration disturbances or (2) regain control of the interface after the application of large disturbing forces. Thus, in 1962, an experiment was carried on the Mercury-Aurora 7 spacecraft that was designed to (1) study the long-term, steady-state configuration of the liquid-vapor interface; (2) determine the ability of the baffle configuration to maintain control of the liquid vapor interface during spacecraft maneuvers; and (3) determine at what acceleration level (during re-entry) control of the interface was lost.[62] A 3.3-in diameter spherical glass tank, partially filled with distilled water and configured with an appropriate baffle, was employed for the experiment. The hardware was placed in the MA-7 capsule, at a position just to the right of the astronaut's head (when he was in a sitting position). During the mission, the tank was filmed by the pilot observer camera located in the instrument panel. The results of this experiment are discussed in detail in this document on p. 12-3.

2. The U.S. Apollo Program

During early manned space flights, such as the Mercury and Gemini programs, the main objectives of the missions were to demonstrate the feasibility of space flight and man's ability to live and work safely in space. During the subsequent manned Apollo program, man not only reached and landed on the Moon, but demonstrated that his involvement in the performance of experiments, observation of phenomena, and operation of the spacecraft was invaluable.[63] Throughout these early flights, there was little emphasis on examining beneficial or problematic fluid phenomena in detail, and experiments designed to study fluids or materials processing initiatives were rarely included in the flight manifest. However, during the Apollo 14, 16, and 17 missions, several small "suitcase" experiments were added to the flight.

The investigations, which were performed during the trans-Earth coast, included (1) a liquid transfer experiment that demonstrated the draining and filling of model storage tanks (Apollo 14), (2) a simple heat flow experiment that illustrated the low-g reduction of buoyancy-driven convection and the presence of Marangoni convection (Apollo 14 and 17), (3) a low-temperature furnace capable of casting model composite systems (four experiments on Apollo 14), and (4) two primitive electrophoresis demonstrations (Apollo 14 and 16). Reportedly, "The power and weight available for such experiments greatly limited their capability and the scientific details that could be obtained from them. All of the experiments operated successfully but revealed the presence of more subtle nongravitational flows that needed further understanding before the microgravity environment could be used to advantage."[3] (The experiments are detailed in this document on pages 12-7 (draining and filling of tanks), 12-13 to 12-21 (convection experiments), 5-3 to 5-13 and 17-3 (casting experiments), and 1-3 to 1-9 (electrophoresis).)

3. The U.S. Skylab Program

Unlike the Apollo program, Skylab was the first U.S. manned program "...with the specific purpose of developing the utility of space flight in order to expand and enhance man's well-being on Earth."[64] Experiments were performed in a number of different scientific disciplines including geophysics, stellar astronomy, biomedicine, "zero-gravity technological studies," etc. One of the specific goals of Skylab was "to develop methods for processing and manufacturing of materials utilizing the absence of gravity."[64]

Reportedly, "The first materials processing experiments approved for Skylab were the welding and brazing demonstrations originally motivated by the desire to fabricate and repair space structures in space. These experiments had been under development since 1964 and were accepted for flight in 1966. As interest in processing experiments in a weightless environment grew, facilities were expanded to accommodate five additional experiments, which were accepted in 1969. The Multipurpose Electric Furnace and 10 additional experiments were proposed in 1971 and accepted for flight in 1972."[5]

The Skylab mission was initiated on May 14, 1973, when the unmanned Saturn workshop was launched into Earth orbit (designated the SL-1 mission). During the following 272 days, nine men in three different three-man crews visited and manned the workshop. (The first crew manned the workshop for 28 days (SL-2 mission), the second crew, for 59 days (SL-3 mission), and the third crew, for 84 days (SL-4 mission).) Throughout this time, the astronauts performed scheduled and unscheduled operations with less difficulty than had been anticipated.[65]

The manned presence at the laboratory was critical when several unplanned events threatened the station and/or the scientific return. For example, when a meteoroid shield, which was designed to protect the station from space particles and provide a degree of thermal shielding from the Sun deployed prematurely 63 s into the unmanned launch of the station facility and was ripped away from the Saturn IVB stage,[66] astronauts on the first manned flight were able to deploy a thermal shield that brought temperatures back to normal within a few days. The same crew was also able to deploy a solar array panel that jammed when the meteoroid shield detached from the Saturn stage during lift-off. All three of the crews performed several unscheduled maintenance tasks.

During the three manned periods in Skylab, approximately 20 experiments were performed in a facility dedicated specifically to materials processing. During the first manned mission (SL-2), a metals melting experiment, exothermic brazing, and sphere forming experiment were performed in the facility. During the second and third manned missions (SL-2 and SL-3), a multipurpose electric furnace housed within the facility was used to perform solidification, crystal growth, and other experiments. Flammability experiments were also performed in the facility during the third manned mission.[3,65]

Fluids and materials processing experiments performed aboard Skylab benefited from the extended-duration experimental time and the astronaut presence. The long-duration mission meant, for example, that processing times could be significantly longer than those available during sounding rocket flights or the short duration Mercury and Apollo flights. In addition, impromptu science demonstrations (employing onboard equipment and astronaut ingenuity) could be performed by the crew. When a member of the the Skylab crew on the second manned mission (Science Pilot Owen Garriott) radioed to Earth that the men wished to perform science demonstrations that would (1) provide additional science data from space and (2) "serve as time-gap fillers and to provide a change of pace for the crew...", 12 science demonstrations were proposed (within a few days) at NASA MSFC. Two of the proposed experiments were considered most compatible with Skylab III and performed on that mission (Diffusion in Liquids and Ice Melting)*.[67] Between Skylab III and IV (less than 52 days), 17 additional science demonstrations were defined in anticipation of excess crew time on Skylab IV. Prior to the mission, supplies were prepared for 11 of the demonstrations.[68] Nearly all of the demonstrations were performed on Skylab IV.[67]

The astronauts manning Skylab also performed/attempted 19 experiments/demonstrations that were proposed by high school students. The experiments were part of an effort designed to "stimulate interest in science and technology among high school students" known as the Skylab Student Project.

Originally, 25 student experiments were selected under the program. These experiments, which had been selected from more than 3,400 proposals submitted by boys and girls, were implemented by associating the student investigator with a Skylab principal investigator who then supported the student experimental requirements.[65] During a preliminary design phase, it was determined that 19 of the selected experiments were suitable for Skylab and they were included in the experiment manifest.[65] Several of the original 25 student experiments were directly or indirectly related to fluids and materials processing goals and are included in this compilation (e.g., Liquid Motion Studies, Brownian Motion Investigation, Capillary Fluid Motion, etc.)

*After the Ice Melting Demonstration, a globule of water remained attached to a retaining stick. Thus, a third impromptu demonstration was performed when it was suggested that soap, water, and other fluids be added to the drop. This experiment is reported on page 12-27.

4. The Apollo-Soyuz Test Project

Additional opportunities to perform fluids and materials processing experiments were realized in 1975 during the Apollo-Soyuz Test Project (ASTP). From 1972 to 1975, both the U.S. and U.S.S.R were involved in preparations for the mission.

Prior to the mission, a total of 161 ASTP experiment proposals (many of which were related to fluids and materials processing experiments) were submitted to NASA Headquarters from scientists in nine different countries. The experiments were reviewed by the National Academy of Sciences and approximately 30 experiments were selected for inclusion on the mission.[70]

During the historic flight (July 1975), a U.S. Apollo spacecraft docked with a U.S.S.R. Soyuz spacecraft. Throughout the following 2 days, the three astronauts and two cosmonauts performed joint experiments, after which time the Apollo and Soyuz undocked. Apollo remained in orbit 3 days longer in order to complete several additional experiments/demonstrations.[69,70] Thirteen experiments/demonstrations performed during ASTP were applicable to this data base and are detailed within this document.

It was reported[5] that although the time to develop experiments was short and resources available for the experiments were more restricted than on Skylab, several ASTP investigators were able to confirm Skylab results and further study fluid phenomena that were observed during previous low-gravity investigations.

V. The Space Transportation System (STS) Employed as a Reduced-Gravity Experimental Facility

1. The Shuttle Vehicle

Approval for the Space Transportation System (U.S. space shuttle) came in 1972 (Reference (71)). Nine years later (April 1981), the first space shuttle (Columbia) was launched from Kennedy Space Center (KSC), Florida. The first two flights of the shuttle were designed primarily to test and evaluate major systems of the shuttle vehicle itself (STS-001 and STS-002) and to perform Earth observation experiments (STS-002). STS-003 carried the first fluids and materials processing experiments performed on the shuttle (e.g., Monodisperse Latex Reactor, Electrophoresis Verification Test). Immediately thereafter, most shuttle flights contained at least one or more experimental payload(s) designed to understand low-gravity fluid/material processes.

Unlike previous Earth-orbiting vehicles, the shuttle can routinely transport research equipment into space and return it to investigators. NASA has implemented several different programs to enable a variety of people to explore worthy research ideas. Thus, experimental investigators have included high school students, college students, fluids and materials processing experts, biomedical personnel, astronomers, Earth observers, IMAX movie makers, etc. Experiments proposed by these investigators can be operated in either a shirtsleeve environment or in an environment exposed to space. Historically, Shuttle orbiting times have varied from 2 days to just over 2 weeks, with low-gravity environments typically varying from 10^{-6} g (steady-state acceleration) to 10^{-2} g (transient accelerations). The nominal altitude for most flights is 160 nmi.[72]

2. Shuttle Experimentation Selection Procedure

A. Solicited and Unsolicited Proposals

The procedure for placing an experiment onboard the shuttle is detailed in Reference (72). In brief, experiments placed on the shuttle come from many sources including (1) NASA, (2) other U.S. agencies, (3) commercial companies, (4) universities, and (5) foreign government agencies (such as ESA).[72] NASA-sponsored investigations are often selected from either solicited or unsolicited proposals. Solicited proposals are generated from investigators in response to an Announcement of Opportunity (AO). The AO's typically solicit ideas to achieve a program objective or to study a specific discipline (e.g., reduced-gravity solidification). Nonsolicited proposals include any proposal not related to a NASA solicitation. In addition, NASA occasionally agrees to support or participate in space research with other U.S. or foreign agencies. In these cases, experiment selection is controlled by a joint agreement between NASA and the agency.[72] Among other considerations, all proposals are reviewed for (1) scientific and technical merit, (2) payload accommodation requirements (Spacelab facility, middeck experiment, etc.), (3) feasibility of developing flight equipment, (4) availability of flight resources, (5) scheduling and cost, etc. Tentatively selected investigations then typically undergo a thorough science and implementation requirements definition study that results in a plan detailing all phases of the project (including equipment development, operation of the equipment on the shuttle, post-flight data analysis, etc.)[72].

B. The Shuttle Student Involvement Project

One of the methods for high school students to place experiments on the shuttle was the Shuttle Student Involvement Project (SSIP). From 1982 (STS-003) to 1992 (STS-42), 23 experiments were flown in the shuttle middeck, which had been proposed by high school students.[73] Like the Skylab Student Project (detailed above), the experiments were part of program designed to stimulate interest in science and engineering among high school students (grades 9 to 12). The SSIP was a joint venture between NASA and the National Teacher's Association. Under the project, students submitted proposals concerning experiments suitable for flight aboard the shuttle.[74]

Originally, 10 experiments were selected from the first competition in May 1981. Shortly thereafter, 20 more experiments were selected from a second SSIP competition in May 1982 (Reference (74)). Throughout the original SSIP program, there were five such competitions, during which a total of 57 experiments were selected by the National Teacher's Association.[73] NASA reviewed the recommended experiments and made the final selection of feasible investigations. These experiments, which had been chosen from thousands of proposals submitted by boys and girls across the U.S., were implemented by pairing each student with a corporate sponsor and a NASA consultant who assisted the student in turning the proposal into a flight-ready experiment.[74]

The experiments were manifested on shuttle missions, and most flew within the next 3 years (1982 to 1985).[75] However, flight opportunities were not readily available on the shuttle (especially after the Challenger accident in 1986), and many students were out of high school and in college when their experiments were performed.

Although detailed information was not available on 5 of the 23 experiments, it appears that overall, 10 of the 23 experiments performed on the shuttle were directly or indirectly related to fluids and materials processing goals. Seven of these SSIP experiments are included in this compilation; information on the other three were not available at this time and/or were beyond the cut-off date for this publication.

Although SSIP experiments no longer fly on the shuttle, there is a derivative of the program still in existence. This derivative is also called SSIP (although the acronym now stands for Space Science Student Involvement Program). This broader program does not include competitions to place experiments on the shuttle, but instead sponsors five other types of competitions including (1) a future aircraft/spacecraft design competition (grades 3 to 5), (2) an interplanetary art competition (grades 3 to 12), and (3) a Mars scientific experiment proposal competition (9 to 12).[76]

The SSIP competition that most resembles the original SSIP program is entitled "Aerospace Internships" (for grades 9 to 12). This competition requires students to propose experiments that could theoretically be performed at one of several NASA facilities (e.g., the Langley Research Center (LaRC) wind tunnel, the LeRC drop tube, the MSFC Spacelab facility, etc.).[76] SSIP winners spend a week internship at a NASA research center observing scientists conducting experiments already in progress (their proposed experiment is not conducted).

Additional information on the current SSIP Program can be found at the NASA Office of Human Resources and Education Division (NASA HQ) or the National Science Teachers Association (Arlington, Virginia).

3. Experiment Configuration

Most of the experimentation performed onboard the shuttle occurs in the astronaut middeck area or the payload (cargo) bay.

A. Experiments on the Middeck

The middeck is located directly below the shuttle flight deck and adjacent to the payload bay. The forward and aft sections of the middeck are depicted in figure 15 (Reference (20)). Fourty-two storage lockers (typically containing food, clothing, equipment, etc.) can be mounted in the deck. For a given mission, any unused lockers and/or their mounting spaces can be configured with experimental equipment.[19] For some missions, other areas of the middeck are also available for experimental equipment (see Reference (19)). In addition to the "Single" (56 by 53 by 201 cm) or "Double" lockers, experiment apparatus containers (EAC's) can be implemented in the middeck area (figure 16).[20] <Note: A derivative of the middeck EAC's are also employed in the payload bay (see pp. 41-42).>

Although the space available for experimentation and power-and-heat rejection capabilities are limited in the middeck, advantages of this location include (1) late access and early recovery of the experimental package, (2) reduced payload integration time and cost, and (3) crew/experiment interaction.

B. Experiments in the Payload Bay

The payload bay, measuring 15 ft in diameter and 60 ft in length, is located between the flight deck/middeck section of the vehicle and the shuttle engines.[19] The bay is used to house a variety of payloads including large experiments, satellites, pressurized Spacelab modules, Get Away Special canisters, etc. Power and heat rejection capabilities of the bay are not as restricted as the middeck area.[19]

4. Shuttle Experiment Carriers Which Have Housed Fluids and Materials Processing Experiments in the Payload Bay

NASA has developed a variety of payload carriers to accommodate investigators. These carriers are typically configured in the the exposed cargo bay. Other experiments, which are initially configured in the payload bay, are placed into orbit about the Earth during the mission and picked up either before the space shuttle leaves orbit or by a shuttle which is launched at a later date (free-flyers). On the more sophisticated end of the spectrum of available carriers are the Spacelab experiment module and retrievable free-flyers; on the other end of the spectrum are small self-contained payload canisters (GAS canisters).

A. Pressurized Spacelab Modules

A detailed description of the Spacelab facility is found in References (19, 71, 72, and 77). In brief, Spacelab is a reusable modular facility, configured in the shuttle payload bay. The facility was designed, built, and financed by 10 European nations through ESA.[77]

During a mission, the facility is exposed to space when the cargo bay doors are opened. Basically, Spacelab consists of two elements: (1) an enclosed pressurized laboratory module (which provides a shirt sleeve research environment for the shuttle crew and accompanying experiments) and (2) unpressurized platforms (pallets) (where equipment such as telescopes, antennas, etc. can be mounted for direct exposure to space and supported with orbiter resources).[20,71] The total Spacelab power level available is 7 kW.[20]

Most often, fluids and materials processing experiments have been performed in the pressurized "long" laboratory module. The module is connected to the lower crew compartment (orbiter middeck area) via a tunnel adapter and tunnel (the Spacelab Transfer Tunnel)[72] (see figure 17 (Reference (71))). The module itself is comprised of 9-ft long, 13-ft diameter cylindrical segments made of aluminum alloys and covered with multilayered insulation. Two such segments are employed to create the "long module" (see figure 18, Reference (71)). The first segment (or core segment) contains controls, monitoring equipment, and research experiments. The second segment (or experiment segment) primarily contains research equipment.[72]

The majority of the equipment in both segments is housed in laboratory racks that line the walls of the module. Up to six double racks and four single racks can be installed in the Spacelab module.[19] The first Spacelab laboratory mission (Spacelab 1) flew on the shuttle in 1983. During this mission and most of the shuttle Spacelab missions (such as Spacelab 3, Spacelab D1, Spacelab D2, Spacelab J, The International Microgravity Laboratory (IML), and The United States Microgravity Laboratory (USML)), a multitude of fluids and materials processing experiments have been performed in this shirt sleeve environment.

B. Small Self-Contained Payloads: Get Away Special Canisters (GAS Cans), MAUS, and Hitchhikers

The STS orbiter payload bay can be used to transport approximately 65,000 lb into Earth orbit. The contents of the bay vary from mission to mission, but for the most part, primary and/or secondary payloads such as satellites, Earth-and-space observation equipment, manned laboratories (Spacelabs), etc., take up most of the available volume in the bay. On average, however, these payloads do not require the entire bay volume and there is sufficient room for additional smaller payloads.[78]

The STS Small Self-Contained Payload (SSCP) program was initiated by NASA to provide individuals and organizations a means of placing a small, (generally scientific) low-cost payload aboard the shuttle on a space-available basis. The NASA GSFC Small Payloads Project (SSPP), which developed and operates the SSCP program, manages two small orbiter bay payload carriers: the Get Away Special (GAS) program and the Hitchhiker program.[79]

Details of the GAS program and Hitchhiker program are provided in References (19, 72, and 78 to 81). GAS canisters are standardized aluminum containers that can house small payloads (see figure 19 (Reference (81))). These containers, which are typically configured in the payload bay on a GAS bridge or via some other standard mechanical interface, can be be evacuated or pressurized. The canisters must contain their own electrical power systems, heating/cooling equipment, data acquisition systems, etc. (if required for the stored experimentation), as well as contain limited electrical interfaces that allow simple crew control functions from the orbiter cabin.[19] The payload has only limited crew interaction interfaces; no more than six simple inputs (on/off commands, initiate special sequence, change data rate, etc.) can be performed by the astronauts via the NASA provided relays.[78]

The standard GAS carriers are available in two different sizes: a 5-ft^3 volume canister and a 2.5-ft^3 volume canister. Users can choose the desired container atmosphere as the internal pressure of the canister can be varied from near-vacuum to approximately 1 atmosphere.[81] Thermal insulation on the bottom and sides of the container provide some thermal protection for the user's payload.

The larger (19.75-in diameter, 28.25-in high) canister can accommodate up to 200 lb of customer equipment; the smaller version can accommodate only 60 to 100 lb of equipment. This equipment, which typically consists of the experiment setup, power source (batteries), sequencing system, and data recording system, is provided by the customer. Often, several experiments are configured into a single canister.
The GAS experiments are divided into three major categories: educational, foreign and commercial, and U.S. Government. In order to assure access to space by a diverse group of users, NASA rotates the GAS flights among the three categories. Within each category, the canisters are flown on a first come, first served basis.[78]

The Hitchhiker carrier, which employs canisters somewhat similar to GAS canisters (although with more complex mechanical and electrical interfaces than the GAS cans), is a modular carrier that is expandable in accordance with payload requirements. Unlike the GAS program, Hitchhiker provides power, data, and command services to the customer's payload. In addition to crew control of the payload, customers at the Hitchhiker control center at GSFC can communicate real-time with the equipment.[79]

The first GAS can to fly on the shuttle was the Getaway Special Flight Verification Payload on STS-003. During this first space test of the payload, the environment of the canister was evaluated. Since this first flight, over 100 experiments have been flown in GAS or Hitchhiker payloads.

An additional small, cylindrical, self-contained reusable payload carrier called MAUS or Materialwissenschaftliche Autonome Experimente unter Schwerelosigkeit (in English, Autonomous Material Science Experiments in Microgravity) is utilized by the Federal German Ministry for Research and Technology (BMFT).[53] The aerospace firm Messerschmitt-Boelkow-Blohm (MBB/ERNO) (Bremen, Germany) developed a standard GAS-Can-type system which is compatible with the interface requirements of the NASA GAS container. Like the GAS canisters, MAUS canisters (1) are configured in the payload bay and are fully autonomous (experiments are initiated and concluded by only a few signals sent by the crew) and (2) house their own power, experiment command and data handling electronics, etc.

C. Free-Flying Satellites Deployed From the Shuttle

C1. The German Shuttle Pallet Satellite (SPAS)

The shuttle pallet satellite (SPAS) was also built by MBB/ERNO and supported by BMFT. The facility, which is a reusable platform designed to operate either inside or outside the cargo bay, can be configured with a variety of commercial and scientific equipment.[82]

MBB allows customers to fly their experiments on the satellite for a fee. For the initial flight of the satellite, NASA agreed to substantially reduce the charge for launching the facility in exchange for testing the shuttle remote manipulator system's capabilities of deployment and retrieval of the satellite.[82] (The facility was the first satellite ever deployed and retrieved from the space shuttle during a mission.)

During the STS-007 mission (1983), the facility, which was carried into orbit by the shuttle in the cargo bay, was configured with 10 experiments furnished by BMFT, ESA, and NASA.[82,83] A (preflight, 1983) diagram of the STS-007 SPAS configuration is represented in figure 20 (Reference (84)). Three of these experiments were related to fluids and materials processing studies. One of these fluids and materials experiments was designed to study heat pipe operation, the others (which were contained in West German MAUS GAS canisters) pertained to the study of Marangoni flow and Mn-Bi solidification. The satellite, complete with experiments, was designated as SPAS-01. Most experiments on the SPAS were designed to operate while the SPAS was in the payload bay; others operated during the short time (approximately 8 h) that SPAS was deployed as a free-flying satellite.

A description of the SPAS deployment and retrieval is presented in Reference (85). During the mission, the shuttle remote manipulator system (RMS) robot arm placed the 16-by 11-by 5-ft SPAS outside the shuttle cargo bay. Then, after the shuttle maneuvered away from the SPAS (305 m), the SPAS was commanded into free-drift mode (shutting off the platform's altitude control system). During the following 2 h, fluids experimentation was performed that eventually was compared to the earlier experimentation performed with the SPAS configured in the payload bay. Approximately 2 h later, the orbiter was maneuvered back toward the satellite, where SPAS was retrieved by the arm. Later in the mission, the SPAS was again deployed, but for a different purpose. After deployment, the shuttle first maneuvered 21 m away from the satellite and then the rate and control system (RCS) thrusters were fired in the direction of the SPAS to see what effect the blasts would have on the pallet. At this distance, the satellite was "buffeted... [and] at times rolled as much as 90 degrees."[85] The test was repeated with the shuttle at a distance of 31 and 61 m. Reportedly, the satellite came through the tests "with no ill effects."[85]

After refurbishing, the SPAS facility, now designated as SPAS-01A, was carried into orbit by the shuttle on STS 41-B (1984). (This reflight of the facility reflected the first time a satellite had ever been refurbished and reflown on the shuttle.)[83] For this mission, the facility carried a variety of experiments, including two materials processing experiments (reaction kinetics in glasses and slip casting). Both of these experiments were housed in West German MAUS containers. Reference (86) indicated that during the mission the satellite was to (1) be removed from the STS payload bay by the RMS arm, (2) remain attached to the arm throughout the mission (at a position overhead about 5 to 10 ft from the forward payload bay bulkhead), and (3) be replaced in the cargo bay prior to the shuttle's return. However, Reference (83) reported that the "SPAS remained [attached] in the payload bay due to an electrical problem with the RMS." Additional information about the SPAS can be located in References (87 and 88).

C2. LDEF

The Long Duration Exposure Facility (LDEF) was a free-flying cylindrical satellite (30-ft long and 14 ft in diameter) originally housed in the orbiter bay and then placed in Earth orbit by the U.S. space shuttle at an altitude of 257 nmi and an inclination of 28.5° (STS 41-C, 1984).[89,90] The structure contained 57 science and technology experiments located in trays mounted on the exterior of the structure. (Only four of these experiments were directly related to fluids and/or materials processing.)

LDEF was to be retrieved by another shuttle after approximately 9 months. However, the structure remained in orbit for nearly 6 years because STS flights were delayed following the loss of the space shuttle Challenger. LDEF was eventually retrieved in January 1990 at an altitude of approximately 180 nmi (STS-032).

D. NASA Office of Space Science and Applications Payload (OSTA-2)

A materials processing payload sponsored by the NASA Office of Space Science and Applications (OSTA) was carried on the shuttle during STS-007 (1983). The payload, designated as OSTA-2, was developed by the U.S. and West Germany.[91] Under terms of a cooperative agreement, scientific data obtained from the payload were shared by both countries.[82]

OSTA-2, which was configured in the payload bay, consisted of two automated experiment facilities. The first, called the materials experiment assembly (MEA) was sponsored by NASA; the second, called Materialwissenschftliche Autonome Experimente unter Schwerelosigkeit (MAUS) was sponsored by the German Ministry for Research and Technology.[91] <Note: Additional (general) information on MAUS experimental facilities can be reviewed on p. 39.> MEA and MAUS were configured within the shuttle cargo bay on a mission peculiar equipment support structure (MPESS). The primary function of the MPESS was to provide mechanical support for the facilities and to elevate "...the MEA package to a height above the level of the cargo bay so that the MEA thermal radiator... [could] dissipate heat from the package into space when the cargo bay doors... [were] open."[82] The elements of the OSTA-2 payload are depicted in figure 21 (Reference (91)).

D1. The Materials Experiment Assembly (MEA)

MEA was a desk-sized facility, managed by NASA MSFC (see fig. 22, Reference (91)). Three experimental apparatuses, each housed in their own experiment apparatus container (EAC), were configured on the facility: (1) an isothermal furnace, (2) a gradient furnace, and (3) a single-axis acoustic levitator. (Each of these apparatuses had been developed and employed during the SPAR program and were modified for MEA performance.) These three facilities supported the following experiments: (1) vapor crystal growth of semiconductor materials (gradient furnace), (2) melting and solidification of liquid miscibility gap materials (gradient and isothermal furnaces), and (3) processing of uncontained glass melts (acoustic levitator). In addition to the EAC's, MEA was configured with the thermal, electrical and data subsystems necessary to support the experiment objectives and equipment within the containers. Not only did MEA require a minimum integration interface with the orbiter, but it also required a minimum amount of attention from the shuttle crew.[82,91]

D2. MAUS (STS-007)

Three automated, MAUS GAS canister-type containers were employed for the West German experiments. Two of the containers were related to an experiment called "The Stability of Metallic Dispersions" and the third container housed equipment related to the study of solidification front physics ("Particle Transport Induced by Directional Solidification").[82] Each of the cylindrical containers was thermally isolated and had its own service module containing experiment hardware, electrical power equipment, experiment control systems, etc.[92]

E. MEA-A2

The MEA-A2 facility was flown in the shuttle bay during the Spacelab D1 mission (1985). The same three MEA-A1 experimental apparatuses were configured on MEA-A2.[93] These apparatuses now supported five experiments: (1) the vapor crystal growth of semiconductor materials (gradient furnace), (2) the directional solidification of PbSnTe (gradient furnace), (3) the melting and solidification of liquid miscibility gap materials (isothermal furnace), (4) the diffusion of lead and zinc (isothermal furnace) and (5) processing of uncontained glass melts (acoustic levitator). (Similar MAUS experimentation was not associated with this MEA payload.)

F. The Materials Science Laboratory (MSL) and the United States Microgravity Payload (USMP)

A third MEA facility was planned, although canceled prior to flight.[94] Before its cancellation, the facility was to fly on what was designated as the Materials Science Laboratory-1 (MSL-1) mission.[94] (Later, the MSL acronym became associated with the materials science laboratory (MSL) experiment carrier.) Although Reference (82) indicated that at least five MSL flights were scheduled to fly on the shuttle, only one MSL payload actually flew on the orbiter (MSL-2).

While the MEA facilities had been basically self-contained payloads operating independently of the shuttle, the MSL payloads were designed to use resources provided by the orbiter (orbiter power, orbiter heat exchanger, etc.).[16,95] Power levels of 470 W could be continuously provided.[20]

The MSL was designed to be a reusable, standard, materials processing experiment carrier. A maximum of three experiments (each contained in an experiment apparatus container, and each weighing a maximum of 308 kg) could be accommodated on the structure.[20] In addition to providing structural support to experiments (via a MPESS platform), this standard carrier was also configured with (1) "standard" subsystems that provided environmental control, power control, command and data management, etc., and (2) appropriate orbiter interfaces (power and heat exchange as mentioned above as well as interfaces for crew commands to the facility).[94,95] It was intended that the standard subsystems support a variety of experiments configured on the facility during the MSL flight history.

MSL-2, which flew on the shuttle in 1986 (STS 61-C), is depicted in figure 23 (Reference (95)). In addition to the standard equipment housed on the MSL (as detailed above), the facility also contained experimental equipment directly related to three different materials processing investigations (an automated directional solidification furnace, an electromagnetic levitator, and a three-axis acoustic levitator.)

MSL-2 flew on the shuttle just prior to the explosion of STS 51-L (Challenger) in January 1996. During the months immediately following the disaster, the backlog of experiments that were to fly on MSL grew. Thus, a new (and improved) derivative of the MSL experiment carrier was designed that could support additional materials processing investigations.[94] This new experiment carrier, which is currently manifested on shuttle missions, is called USMP. In addition to accommodating twice as many investigations as the MSL, the USMP (1) can provide more resources to each experiment (the facility can be allocated up to 50 percent of the total orbiter resources available for payloads) and (2) has improved data handling and command capabilities (including real-time command and data analysis capabilities by investigators on the ground).[96] The facility, which employs two MPESSs mounted adjacent to each other, spans the width of the orbiter. USMP subsystems, mounted on the forward MPESS, provide resources to the science experiments (fig. 24).[96] Experiment hardware is mounted on the tops and sides of each MPESS (e.g., figure 25).[96]

The first USMP, designated as USMP-1, flew on the shuttle in 1992; USMP-2 was flown in 1994. Several additional USMP flights are planned. (Additional information on the USMP can be located in References (96 and 102).)

G. Other Current Carriers

Recently (post-1989), additional carriers have been employed to place experiments on the shuttle (i.e., Spacehab, and the European Retrievable Carrier (Eureca))

Detailed descriptions of these carriers are not presented here as this hardcopy version of the data does not contain summaries of these recent experiments.

VI. The Need for a Data base

1. Creation of a Data Base to Highlight Low-Gravity Fluid Response

NASA MSFC has played a major role in low-gravity fluids and materials processing investigations throughout its history. Principal- and/or co-investigators from MSFC have proposed, designed, and implemented numerous experiments on almost every type of low-gravity terrestrial and extra-terrestrial facility described in the previous sections. A small sampling of MSFC past experiment involvement is represented in table 2. In addition, MSFC personnel are currently heavily involved in STS mission science and experiment implementation.

Table 2

MSFC Investigator	Mission	Experiment
Bannister	Apollo	Heat Flow and Convection
Baugher	STS	Acceleration Measurement
Carter	STS	Protein Crystal Growth
Darbro	Skylab	Liquid Films
Facemire	Skylab	Diffusion
Johnston-McCay	SPAR	Alloy Solidification
Kornfeld	STS	Monodisperse Latex Reactor
Kroes	STS	Fluid Experiment System
Lacy	Skylab	Immiscible Liquids
Lacy	ASTP	Synthetic Alloys
Lee	STS	Crystals in Aqueous Soln.
Lehoczky	STS	Crystal Growth
McKannan	Apollo	Electrophoresis
Poorman	Skylab	Metals Melting
Schafer	SPAR	Liquid Mixing
Snyder	Apollo, STS	Electrophoresis
Snyder	STS	Electrohydrodynamics
Vaughan	Skylab	Water Drop Dynamics
Vaughan	Skylab	Acoustic Positioning
Whitaker	ASTP	Capillary Wicking
Whitaker	STS	Tribology
Williams	Skylab	Brazing
Yates	Apollo	Composite Casting

Bob Naumann (a former MSFC scientist), took a detailed look at many early low-gravity fluids and materials processing experiments and summarized what scientists and engineers had discovered in several areas of reduced-gravity research. In Naumann's 1980 book entitled "Materials Processing in Space: Early Experiments" (Reference (5)), for example, significant findings in the area of crystal growth, metallurgy, and fluid phenomena were related. While it was reported that in many cases, experimenters observed expected results, often times there were also a number of "surprises," some of which were thought to be of significant scientific value. Specifically, he noted that "In the area of fluid phenomena there appears to be considerable confusing data, indicating that there is still much to be learned about the behavior of fluid in a low-gravity environment."

MSFC scientist Charles Schafer performed experiments on the SPAR sounding rocket in 1975 and 1976, which were specifically designed to determine the effect of the vehicle's acceleration on pure diffusive mixing.[97] The experiment, which involved the melting and solidification of three cylindrical samples during the low-gravity phase of the rocket, illustrated that pure diffusive mixing between a section of pure indium joined to a section of indium-lead was not observed, but rather the magnitudes of convective flow experienced in the samples were related to the vehicle's acceleration environment. Today, many scientists attribute unwanted or unanticipated convective flow fields observed during reduced-gravity investigations to the vehicle's (low-gravity) acceleration environment.

A significant review of both early experimental results and more recent investigative efforts indicate that fluid characteristics have rarely been systematically examined over several missions. While a single investigator may have performed experiments in a logical way changing only one or two variables (such as Schafer), in most cases, analysis of the contribution of each variable to the resulting fluid response has not been realized. Not only have most past experiments been significantly complex (involving several fluid dynamic parameters), but associated investigators (within the same research area) have rarely employed the same sample materials, thermal and solutal gradients, crucible materials, etc. As a result, in only a few instances has low-gravity fluid response appeared to be sufficiently understood to confidently exploit the benefits into profitable space processing ventures. Particular investigators have realized major successes in terms of using reduced gravity to achieve particular objectives, but few have returned with (1) space processed materials that were significantly superior to those produced on Earth, or (2) sufficient experimental evidence to support definitive flow theories.

Because it was recognized that many aspects of fluid response in the low-gravity environment were still not well understood by the scientific community as whole, and that vehicle accelerations may play a significant part in the results achieved by experiments, scientists at MSFC wanted to create a data base that was designed to highlight the basic fluid flow processes that govern most low-gravity fluids experiments. It was surmised that once these flow processes were better understood, space experiments and computational models could be designed to more accurately exploit and predict space fluid dynamics. It was clear, that to better understand the fluid dynamics governing each of these systems, the objectives, setup, inflight procedure, and results of these investigations had to be determined and studied. Thus, work related to identifying and cataloging information related to past experiments was initiated.

Within several months, nearly 500 fluids and materials experiments (all of which had previously been performed in sounding rockets or orbiting manned spacecraft) were identified. Soon thereafter, outline information about each investigation was placed into a data base.

2. Creation of a Historical Experimental Record to Serve Scientists Worldwide

Although it was originally planned that the data base would be used as an in-house tool to help highlight governing flow processes, requests for information from the MSFC-housed base came weekly after news of the data base and its contents became publicized. Personnel requesting information were not interested in using the data base to understand flow processes, rather they were intent on locating information on experiments previously performed in their particular research area. The first of these requests came long before most of the objectives, setup, inflight procedure, and results of these 500 experiments had been discerned and documented in detail in the data base.

Scientists and engineers continually sought information from the MSFC data base because such a similar compilation of these reduced-gravity experiments was not available elsewhere. Without such a catalog, interested science communities could not begin to comprehend the vast number of experimental objectives, parameters, conditions, etc., that had already been analyzed in terrestrial and extra-terrestrial low-gravity facilities. Although some investigators that were already active in the low-gravity experimental community were aware of past and current research/proposals in their specific area of interest, new (or would-be) investigators outside this community had very limited knowledge of these experimental efforts. The lack of historical scientific record made it difficult for new investigators to propose up-to-date, valuable research (especially studies related to significant understanding of fluid phenomena), although they had formulated innovative experimental objectives.

In addition, while it was imperative that all scientists proposing new space research understood lessons learned in the past, many researchers remained unaware of the number of low-gravity experiments that had been completed in their subject area. One GAS can investigator, whose experimental equipment had already been delivered to NASA KSC for implementation into the shuttle, thought his foaming experiment was the first to fly on such a vehicle.[98] He was surprised to learn that several such experiments had been performed previously in a reduced-gravity environment.

It soon became clear to both MSFC and NASA-Headquarters management that there was a great need for a historical compilation of the experiments accessible to researchers worldwide. An electronic data base cataloging these experiments would provide an invaluable source of information on low-gravity investigations that could later be employed to highlight important flow processes. The data base would not only serve current and future experiment proposers, but would also be an invaluable educational tool for universities and other institutions interested in low-gravity science issues. The compilation would also provide a historical record of low-gravity initiatives.

Thus, despite the importance of an in-house study to examine earlier investigations and determine the contribution of low-gravity fluid phenomena, completion of information related to each of the experimental investigations became the immediate goal. Once this information was assembled and the data base was available on-line and in hardcopy format, the authors could then compare, analyze, and evaluate the roles of flow parameters and governing fluid physics in experimental systems.

Still, in an effort to identify and tag the governing fluid dynamics for each of these experiments (for this later study and for on-line or hardcopy data base use), an extended key words section (which included fluid characteristics) was prepared for each of the investigations. It was hoped that via these key words, data base users would search for other experiments that had similar fluid dynamics challenges. It was recognized that while many of the experiments appeared to be vastly different from one another in terms of basic research area (solidification of melts, protein crystal growth, vapor diffusion, electrophoresis, etc.) they were driven by similar flow properties (e.g., convection, diffusion). Thus, it seemed critical that investigators became aware not only of research efforts in their major area of interest, but also of seemingly unrelated scientific endeavors that were similar in terms of governing fluid dynamic phenomena.

3. Identifying Past Experiments/Limiting the Scope of the Data Base

When work on the data base was initiated in 1986, its authors were unaware that hundreds of fluids and materials processing experiments had already been performed in terrestrial and extraterrestrial low-gravity environments. Merely identifying (a) the titles of all past experimental efforts and (b) the principal investigators associated with these experiments was a significant task.

While experiment/investigator lists for some carriers were fairly well documented (SPAR, Consort, MASER, Skylab, and ASTP), similar lists for other carriers/low-gravity facilities proved harder to find. For example, there were no composite lists of experiments performed in the KC-135 aircraft, the MSFC or LeRC drop towers, the Mercury and Apollo Spacecraft, the Aerobee and TT-500A sounding rockets, and the Space Transportation System. Thus, a massive search to identify these individual past efforts was initiated. Hosts of historical and flight-related documents were scoured for payload/investigator listings.

Because the number of terrestrial and extra-terrestrial experimental efforts performed to date (then 1986) topped 700, it was determined that the scope of the data base had to be limited to some degree to insure completion of a good compilation. **Thus, although terrestrial low-gravity experimental efforts were viewed as extremely important, it was determined that only experiments that experienced more than 4 min of reduced gravity experimental time would be considered for the data base.** This decision (to omit terrestrial reduced-gravity research efforts performed in laboratory, drop tower, drop tube, and low-gravity aircraft facilities) stemmed not only from the large number of longer-duration investigations that had already been performed, but also from the difficulty in finding listings and further information on the past terrestrial experiments.

During the early days of the data base compilation effort, information was gathered on all the (then previous) reduced gravity experimentation performed on (1) U.S. manned space vehicles, (2) payloads deployed from U.S. manned space vehicles, and (3) sounding rockets (excluding Soviet and Chinese programs). After these experiments were identified and outline information about each placed in the data base, in-depth searches for additional data on each of the investigations began. Based on these searches, information concerning these pre-1987 investigations was continually upgraded and refined.

Simultaneously, outline information on new investigations (performed after 1986) was entered in the data base as low-gravity flights were completed. Each of these newer outlines could not be significantly expanded until long after their associated low-gravity experiment flight date (as detailed (published) postflight information typically did not become available for 1 or 2 years).

When it was later decided (1988) that a complete historical record of past experimental initiatives should be published in electronic and hardcopy formats, the following was recognized:

(1) Experiment descriptive data describing each of the 600 investigations then contained in the compilation had to be expanded past the outline information stage to include detailed experiment summaries.

(2) Entry and expansion of data related to new low-gravity initiatives had to be curtailed in order to complete the detailed summaries described in (1). Thus, only outline information about new experiments would be entered into an electronic version of the data base until the first hardcopy release of the initial 600 experiments was available.

4. Types of Experiments Selected for Data Base Inclusion

Experiment types selected for data base inclusion extended from basic fluid flow examinations to complex materials science initiatives. **The goal was to include all carry-on (manifested) EXPERIMENTS (affected by low-gravity fluid physics) which were performed (1) on U.S. manned space vehicles, (2) on payloads deployed from U.S. manned space vehicles, and (3) on sounding rockets (excluding the Chinese and the (former) Soviet programs).** These experiments included (a) initiatives that were performed primarily to examine low-gravity fluid statics and dynamics (including experiments that sought to explain fluid flow theories), (b) initiatives that were performed to examine flow processes related to biotechnology or materials processing, and (c) all materials processing experiments. Historically, most of these experiments had been performed to explore beneficial flow fields expected in the reduced-gravity environment.

Major titles of research suitable for inclusion in the data base were as follows:

Bioprocessing/Biological Experiments
Capillarity
Combustion
Composites with Gases
Composites with Solid Particles
Critical Point Phenomena
Containerless Processing
Crystal Growth from Solution
Crystal Growth from the Melt
Crystal Growth from the Vapor
Diffusion
Fluid Physics
Liquid Phase Sintering
Metals and Alloys
Physical Chemistry/Phase Transition
Protein Crystal Growth
Systems Exhibiting a Miscibility Gap
Technological Experiments

5. Types of Experiments Not Considered for Data Base Inclusion

As stated above, although terrestrial low-gravity experimental efforts were viewed as extremely important, only experiments that experienced more than 4 min of reduced-gravity experimental time were considered for the data base. In addition, fluid analyses and/or fluids experiments related to the successful operation of (1) the low-gravity vehicle itself (propulsion systems) or (2) the housekeeping equipment/facilities employed on the vehicle were not considered for inclusion in the data base. Although the operation of these vehicle systems was dependent on reduced-gravity fluid phenomena, they were rarely considered "experimental payloads."

Typically, experiments/analyses pertaining to the following were not entered into the data base: (1) ground-based (1-g) laboratory investigations performed in preparation for a sounding rocket or manned spacecraft experiment; (2) ground-based reduced-gravity efforts performed in laboratories, aircraft, drop towers, and drop tubes; (3) experiments performed on suborbital vehicles directly related to heat pipe development; (4) experiments performed on an orbital or suborbital vehicle designed to determine the operation of that or another low-gravity vehicle during lift-off, free fall, orbit or re-entry (e.g. sloshing of vehicle's fuel tanks, fluid distribution at the vehicle's propulsion intake pump, etc.; this includes Aerobee sounding rocket experiments); or (5) analyses of major housekeeping systems or experimental facilities that employ fluid processes (e.g., waste management facilities, vehicle cooling/air loop, fluid/thermal distribution of materials processing furnaces, etc.).

6. Missions Encompassed and Detailed in this Technical Memorandum

This technical memorandum contains the first hardcopy release of the data base and details the nearly 600 experiments performed during the programs listed in table 3.

Table 3
Experiments detailed in this technical memorandum were performed:

(1) Throughout the duration of the Mercury, Apollo, Skylab, and Apollo-Soyuz missions (1962-1975)
(2) Throughout the duration of the Space Processing Applications Rocket (SPAR) program (1975-1983)
(3) During the German sounding rocket program up to TEXUS 18 (1977-1988)
(4) Throughout the duration of the Japanese TT-500A program (1980-1983)
(5) During STS program through STS-32 (1982-January 1990)
(6) During the Consort sounding rocket program prior to Consort 2 (1989)
(7) During the Swedish MASER program through MASER 2 (1987-1988).

A summary of the experiment types detailed within this technical memorandum is presented in table 4.

Table 4
Experiment Types Within this Technical Memorandum

Program	Number of Experiments	
Mercury and Apollo*		11
Skylab		46
Apollo-Soyuz Test Project		13
U.S. Space Shuttle		227
Spacelab Missions		
Spacelab 1 (1983)	36	
Spacelab 2 (1985)	3	
Spacelab 3 (1985)	5	
Spacelab D1 (1985)	49	
Middeck	50	
Payload Bay**	84	
Sounding Rocket Programs		
U.S. SPAR		46
German TEXUS		193
Japanese TT-500A		14
Swedish MASER		15
U.S. Consort		23
		588

* The only missions which appear to have had such experiments were Mercury-Aurora 7, and Apollo 14, 16, and 17.

**Excluding Spacelab Missions, but including (1) GAS Cans and MAUS cans, (2) Payload Bay Carrier Systems (e.g., MEA and MSL), (3) Free Flying Satellites deployed from the Payload Bay (e.g., LDEF and SPAS).

7. Data Sources

The majority of the information in the data base was extracted from publications that detailed experimental information. Most of these publications were located via electronic literature searches using the NASA Research Connection (ReCon) system at the Redstone Scientific Information Center, Huntsville, Alabama.

Because principal and co-investigators were typically the authors of published information describing experiment objectives and postflight results, identification of these key personnel was critical. Once associated investigator(s) were identified, their names were entered into the ReCon system and author searches were performed. Each of these searches resulted in an electronic listing of papers (with abstracts) authored by the investigator. After the abstracts were read, publications applicable to low-gravity research were obtained from the library. Later, these publications were studied and detailed information concerning past experiments was entered into the data base. All in all, over 500 such author searches were performed, resulting in the review of thousands of abstracts and documents.

Although much of the general information about each of the experiments could be located in published documents (typically experimental objective, payload type, processing facility, mission, and mission date), these information sources often did not specifically contain data such as co-investigators, materials processed in the low-gravity environment, builder of the processing facility, details of experimental results, etc. Often times, even distinctions between ground-based and low-gravity experiments were difficult to discern from available publications.

In addition, information related to specific classes of experiments proved particularly difficult to obtain. For example, several times, significant details concerning STS GAS can experiments could not be attained. The major reasons for the lack of reported GAS details were (1) several GAS can experiments were privately funded and the users were not required to document results, (2) a significant number of GAS can experiments failed and investigators did not wish to document these difficulties, (3) most GAS investigators realized that they had one and only one shuttle flight opportunity and thus did not have to illustrate by their reported results that they merited additional flight opportunities, and (4) many GAS can investigative teams involved high school or college students who were (a) not accustomed to publishing papers related to scientific research or (b) graduated prior to the launch of their payloads and then did not write postflight reports.

Because a significant amount of data could not be discerned for several of the low-gravity experiments, investigator input and review of information was sought to (1) help fill in missing information related to several data fields and (2) insure accuracy in reporting information.

8. Querying Investigators

The Center for Space and Advanced Technology (CSAT), Huntsville, Alabama, was contracted to help with this query of experiment investigators. The primary objective of the three-person CSAT task force was to place the (electronic) data base information into hardcopy questionnaires for review by investigators.[99] To achieve this task, both CSAT and the only NASA engineer working on the project (1) reviewed experimental information already in the data base, (2) acquired multiple experiment-related publications pertaining to the experiments, (3) amended experiment records adding some missing information into the records that was required before query sendout (excluding experiment summaries), (4) formulated specific questions for investigators asking them to clarify confusing items presented in available publications, (5) contacted investigators via phone to obtain basic information such as current address, materials processed, etc., and (6) reformatted the electronic data base records into mailable questionnaires for the investigators.

Via these queries, one or more of the suspected principal investigators for each experiment was/were contacted by mail and asked to (1) assess the accuracy of the existing data base information on their experiment; (2) make additions where information was unclear and/or missing; (3) write an short (18 line) experiment summary describing the objectives, setup, and results of the low-gravity investigation; and (4) send publications which described the low-gravity investigation.

Over 600 of these queries (at least one for each experiment in the data base) were mailed by CSAT to nearly 300 investigators worldwide (several of the 600 experiments in the data base had the same principal investigator). "Simply" locating the current address of nearly 300 principal investigators, was in itself, a significant task.

Items sent in the mailings to investigators consisted of the CSAT cover letter (included in the appendix to this introduction), a typical investigator questionnaire, and a sample of what a data base entry was expected to look like. CSAT kept a log of the number of questionnaires sent, date mailed, date of reply receipt, and number of queries returned.

From this initial query to investigators, approximately 40 percent of the 600 experiments were reviewed to some degree and returned (less than 1 percent of the summaries were sent back marked "Returned to Sender"). The majority of the queries returned by the investigators included one or more of the following: (1) identifications of additional principal and co-Investigators, (2) minor changes/additions to the original information sent to the investigators, and/or (3) identification of additional publications that described the research. Only approximately 60 of the 600 queries were returned with the requested experiment summary describing experimental objectives, setup, and results, and of these, approximately 30 were written well enough to sufficiently describe the experiment. Often times, handwriting of the investigators was difficult to read, or the English responses from foreign investigators were difficult to decipher.

9. Procuring Documents to Allow Preparation of Experiment Summaries

After inputting the information provided via the investigator responses into the data base, it was clear that over 500 experiment summaries had to be prepared based on available documentation describing each experiment. Although initially, CSAT had written 40 short (18 lines or less) experiment summaries, it was decided that experiment descriptions would be more effective if they were much longer and more descriptive. As a result of this decision, these 40 CSAT summaries were eventually rewritten.

In order to write these detailed experiment summaries, extreme efforts were made to procure every experiment-descriptive document pertaining to each investigation in the data base. Among these documents were several experiment-related articles that had been published in a foreign language. In many cases, these articles were translated for use in the experiment summaries (especially if insufficient information on the experiment was available in English). Not all non-English documents could be translated in the interest of time (re: timely release of this TM and on-line versions of the data base).

Although some investigators via their response had identified additional references describing the experiment, most did not send copies of these documents (although asked to do so). Often these references proved to be highly obscure (in-house reports, contractor reports, conference poster sessions, non-English publications, etc.) and could not be attained. Thus, several key publications could not be attained prior to the release of this technical memorandum.

10. Preparing Meaningful and Complete Experiment Summaries

After the CSAT contract had ended, a two-man task force from Wyle Laboratories was contracted to aid in the preparation of these summaries. This new contractor effort was funded via the MSFC Commercial Projects Office (PS05). (PS05 was aware of the data base and wanted to see the experiment summaries completed in a timely manner.) One of the Wyle contractors searched for experiment-descriptive documents; the other (J. Jones) aided the only NASA engineer working on the project (C. Winter) in the writing of the 500+ experiment summaries.

Identifying missing information related to each of the data fields and writing the remaining experiment summaries proved to be a gigantic task. Hours, months, and years of studying experimental reports, newspaper articles, journal articles, etc. were required to fill in the missing descriptions of each of the individual data fields. To achieve these ends, Winter and Jones (the authors of this TM) read and summarized information from over 2,000 sources. Most often, the length and detail of the resulting experiment summary was directly related to the amount of descriptive information published about the investigation.

Experiment summaries were written with the several goals in mind:

First, the experiment summary was written such that the average reader could understand the objectives and direction of the scientific research without being a specialist in that research field. To achieve this goal, the summaries most often began with background information on the scientific area being investigated (for example, explaining (a) what electrophoresis is and its importance, (b) why foamed metals are considered valuable, (c) why the reduced-gravity environment should aid in the study of critical point phenomenon, etc.).

Second, every attempt was made to identify experiments that were performed in a series by an investigator or group of investigators (i.e., results from an earlier experiment in the series were used to define objectives/experimental parameters for later experiments in the series). This was done to insure that the logical progression of the overall research effort could be followed by the user. (It should be noted however, that identifying a series of experiments was often difficult because the (1) principal investigator(s) throughout the series were different, (2) there was no mention in applicable literature as to a research progression, and/or (3) later experiments did not appear applicable to the initial investigations.)

Third, great efforts were made to insure that experimental objectives, setup, inflight procedure, and results were clearly reported (especially since pictures and graphs of the experiment/associated data would not be available in early releases of the information). To understand and report these experiment details, every publication collected concerning an experiment was consulted for input into an experiment summary. Specifically, significant results were highlighted in terms of fluid dynamic phenomena where possible.

Fourth, when preparing the descriptive summaries, experimental success in terms of planned objectives were highlighted, rather than experiment failures. However, experiment anomalies were briefly detailed when investigative results were significantly affected by these problems.

Fifth, information that was difficult to understand was often quoted directly from the source. Quotes were also used to highlight major experimental results, report critical information related to the experiment, identify experiment anomalies, or to simply re-state information as provided in available sources.

Sixth, notes from the author of the experiment summary were included to help the data base user understand a variety of items concerning the experiment. Often these notes indicated that available information was (1) conflicting with other sources, (2) difficult to understand, (3) did not follow a logical path, (4) not published in English, or (5) not received prior to the release of the TM.

Seventh, although many investigators were contacted by phone to initially obtain outline information (such as current mailing addresses, principal investigator designations, etc.) and several verbally detailed experiment anomalies and other information, experiment summaries were generally not written based on this "word of mouth" information. Great efforts were made to use published documents to describe the experiments and any associated difficulties.

11. A Second Query to the Investigators

After all the experiment summaries were prepared, information available on each investigation was once again sent to at least one of the identified investigators. This time, approximately 600 principal and/or co-investigators were contacted for their input and evaluation. This second query was done (1) to insure all research efforts were accurately represented in the data base, and (2) to give investigators a second chance to review the information within the data base before it was published and electronically placed on-line. Samples of items sent in the mailings to investigators are in the appendix to this introduction. These items included the Wyle cover letter and a typical investigator experiment summary complete with an "Additional Questions" section.

Response from the investigators was better than expected, especially since they had been told that if no response was received, it would be assumed that the experiment summaries were correct as written. (The investigators were given a fixed amount of time in which to respond with corrections and/or additions to their experiment record. In addition, they were informed that if no response was received from them in this period of time, the information in each of their records would be assumed to be correct.)

Approximately 50 percent of the experiment summaries were evaluated and returned by the Investigators. The investigator input was invaluable as in some cases unknown Co-investigators were identified, unpublished experimental results were detailed, etc. Although it was clear that almost all of the returned experiment summaries had been read thoroughly (as was evident from slight corrections made throughout the body of the summaries), very few editorial changes/additions were made by the investigators, thereby indicating that the quality and content of the summaries were acceptable and accurate. Several positive comments were received from investigators; only one of the 600 expressed that he was somewhat dissatisfied with the summary of his experiment (although this investigator did not rewrite the displeasing sections). The summary was carefully rewritten to reflect his comments.

Although many investigators cited several new information sources concerning their experiments, not all of these data sources could be attained in a timely manner (prior to the release of this TM). However, nearly all sources of information cited by investigators were added to the "References/Applicable Publications" field of each experiment entry.

12. Data Base Format

The MSFC-designed data base format has changed slightly over the years, as need and interest of users dictated. The basic design, however, has remained the same and presents all information describing a single low-gravity experiment in a single data base record. In general, the data base contains a separate record for each flight of an experimental investigation. An example of one record from the data base is presented on the next page. (The summary has been severely abridged to fit within the confines of a single page.)

Each record has 18 separate data fields. These fields are highlighted by the **bold-face** type in the example and contain a variety of information such as principal and co-investigators, mission, experiment name, key words, etc.

Example of One Experiment Record in the Data Base

Principal Investigator(s): Hart, J. E. (1)
Co-Investigator(s): Toomre, J. (2), Gilman, P. (3),...
Affiliation(s): (1) Department of Astrophysical, Planetary and Atmospheric Sciences, University of Colorado, Boulder, (2)...

Experiment Origin: USA
Mission: STS Launch #17, STS-024 (STS 51-B, Spacelab 3...
Launch Date/Expt. Date: April 1985
Launched From: NASA Kennedy Space Center, Florida
Payload Type: STS Spacelab Facility, Spacelab Rack
Processing Facility: Geophysical Fluid Flow Cell (GFFC)
Builder of Processing Facility: Aerojet, Azusa, California

Experiment:
Geophysical Fluid Flow Cell (GFFC)

... The specific objective of this Spacelab 3 experiment was to study the interaction of rotation and convection similar to that which occurs in the atmosphere of a rotating planet like Earth or Jupiter....

Key Words: Fluid Physics, Contained Fluids, Spinning Containers, Rotating Atmospheres, Rotating Fluids...

Number of Samples: one hemispherical shell
Sample Materials: silicone oil (0.65 centistoke viscosity)
Container Materials: inner shell fabricated from polished nickel; outer shell fabricated from transparent sapphire...

Experiment/Material Applications:
Simulation of planetary atmospheres is achieved by producing rotating, spherical convective flows with effectively radial gravity fields induced by dielectric polarization forces.

References/Applicable Publications:
(1) Hart, J. E., Glatzmaier, G. A., and Toomre, J.: Space-Laboratory and Numerical Simulations of Thermal Convection in a Rotating Hemispherical Shell with Radial Gravity. Journal of Fluid Mechanics, Vol. 173, 1986, pp. 519-544. (post-flight results)...

Contact(s):
Dr. John E. Hart
Department of Astrophysical Planetary and Atmospheric Sciences
Campus Box 391
University of Colorado
Boulder, CO 80309

A listing of all of the field names (and associated field contents) is presented below:

Field Name	Field Contents
Principal Investigator(s)	Name(s) of principal investigator(s)
Co-Investigator(s)	Name(s) of co-investigator(s)
Affiliation(s)	Principal- and co-investigator(s) (1) affiliation(s) (institution or company) both at the time of the flight experiment and currently (if different) and (2) location(s) of the named affiliation(s)
Experiment Origin	Country from which the experiment originated
Mission	Specific mission on which the experiment was performed
Launch Date/Expt. Date	(1) Month and year of vehicle launch or (2) experiment date (Skylab only)
Launched From	Vehicle launch location
Payload Type	Type of experimental payload (e.g., sounding rocket, STS Spacelab, STS GAS canister)
Processing Facility	Name (and possibly) brief description of experimental hardware
Builder of Processing Facility	Name and location of the builder of the experimental hardware
Experiment	Experiment summary which includes (1) the experiment name, (2) the experiment number (if applicable), and (3) a description of experiment objectives, setup, and results
Key Words	List of subject titles associated with the experiment/research

Number of Samples	Number of samples employed during the low-gravity experiment
Sample Materials	List of employed sample materials
Container Materials	List of employed container materials
Experiment/Material Application	Brief discussion of (a) the usefulness/application of the sample material and/or experimental process or (b) the reason(s) low-gravity research was warranted.
References/Applicable Publications	List of identified references describing (1) the low-gravity experiment, (2) the employed processing facility, or (3) other related work (i.e, ground-based experiments performed in preparation for the flight, directly associated mathematical analyses, etc.)
Contacts	Name(s) and work address(es) of investigator(s) or other contact(s) associated with the experiment

---

The major portion of each record is contained within the experiment field. As detailed on pp. 56-58, the field usually includes (1) a short background describing the 1-g constraints on the system of interest, (2) a statement of the experiment objective(s), (3) a description of the processing facility and inflight experimental procedures, and (4) a discussion of the results. If the experiment was one in a series of low-gravity investigations, then a statement to this effect is also included in the summary as well as a list of previous experiments in the series. This assures that the logical progression of the research effort is identified.

For each of the nearly 600 investigations contained in this TM, great effort was made to insure that information applicable to each of the 18 data fields was documented.

13. Quantity of Data Available in Each Experiment Record

Because most of the compiled data is a result of information gathered from open literature and investigator response, the clarity of the information as it relates to experimental objectives, setup, inflight procedure, and results depends greatly on the amount of available documentation of the experiment and the amount of investigator input.

14. Categorizing the Experiments Within the Data Base

Categorization of the experiments within the data base (i.e., the separation of the 600 experiments into chapters for this technical memorandum) was difficult to do. It was not clear if categorization criteria should be (1) like boundary conditions (e.g., free surface systems, contained systems), (2) suspected dominating flow processes (e.g. Marangoni flow, convection related to vehicle acceleration), (3) scientific objective (e.g. crystallization, pure diffusion, liquid stability), (4) observed undesirable low-gravity flow characteristic (e.g., poor mixing, electroosmotic flow, deleterious capillary flow), (5) research area (bioprocessing, vapor crystal growth, protein crystal growth), or (6) some combination of the five.

For example, several experiments had been performed in the space environment to study the flow processes governing the production of crystals using a floating zone. Not only do the thermal and solutal gradients in this system play a major role in the resulting solidified crystal, but the free surface of the zone introduces Marangoni forces, and the suspended molten section of the zone is susceptible to gravitational accelerations. Thus, it was difficult to discern if this experiment should be categorized with (1) all free surface experiments (with and without thermal and/or solutal gradients), (2) all experiments which should be governed by Marangoni flow, (3) all float zone crystallization experiments, (4) all experiments affected by either (a) unwanted capillary flow or (b) residual acceleration effects, (5) all experiments involving crystal growth from the melt, or (6) some combination of these criteria.

After much consideration, it seemed reasonable that the categorization criteria should be selected based on past database-user information requests.

15. Past Requests for Information In the Data Base

Many requests for information in the data base had already been fielded by its authors, and the requests were as varied as the experiments themselves. While the majority of people asked for listings of experiments in a certain research area (i.e., solution crystal growth, vapor crystal growth, metallic foaming, etc.), a significant number of requests were made for lists of fluid systems which exhibited a particular (undesirable) flow characteristic (i.e., (a) poor mixing, (b) unwanted bubbles, (c) unexpected agglomeration, and (d) undesirable liquid configuration).

Categorization of experiments by either desirable or undesirable flow characteristics (instead of similar research area) would be extremely interesting for the purposes of understanding low-gravity fluid phenomena, but would hamper most data base users searching for information in a particular research area. For example, a listing of fluid systems that exhibited an undesirable low-gravity configuration would include (but not be limited to) (a) insufficient wetting of a melt to a crucible, (b) insufficient fluid positioning at an inlet port during fluid transfer, and (c) lack of liquid anchoring to disks that contain a liquid bridge. Although these particular experimental systems are mainly dependent on reduced-gravity capillary flow and wetting conditions, they clearly do not belong to the same scientific discipline (represented are solidification of alloys, fluid transfer, and liquid bridge creation).

Because the majority of previous requests for information had been for experiments categorized by research area, this criteria was used to formulate the chapters of this TM. However, although desirable and undesirable fluid characteristics related to each of the experiments were not used as the main categorization criteria, they are detailed in the accompanying key words data fields. In addition, boundary conditions, suspected dominating flow processes, scientific objectives, and even the categories themselves are listed in this key words section. Because this hardcopy version has an extensive key words index, experiments with like flow characteristics can be identified in this document.

VII. The Hardcopy Version of the Data Base

1. Importance of a Hardcopy Version

Because the experiments were categorized by research area, this technical memorandum (1) identifies for current and would-be investigators the major areas of research that have been of interest to previous investigators, (2) documents the chronological history/progression of the low-gravity research in each of these major areas, (3) permits identification of areas of research that have been ignored or insufficiently examined, and (4) illustrates the success of any one area of research as it relates to (a) understanding low-gravity fluid sciences or (b) exploiting the low-gravity environment for advanced technology.

Although experimental efforts can be arranged chronologically and by specific areas of research using an electronic form of the data base, the electronic compilation does not easily illustrate many aspects of the progression of low-gravity research. Thus, the hard-copy version is both a teaching tool to users previously unfamiliar to low-gravity experimentation and a chronological history of low-gravity research. The chronological history is of special value because it enables the user to (1) determine if the low-gravity experimental program has progressed in a logical manner, (2) determine which low-g governing fluid parameters are now sufficiently understood and which are still greatly misunderstood, (3) identify areas of research that have been ignored or insufficiently examined, (4) examine the success of any one area of research as it relates to (a) understanding low-gravity fluid sciences or (b) developing advanced technologies and (5) evaluating the low-gravity program as a whole in terms of cost versus return.

2. The Chapters (Categories) of This Technical Memorandum

There are 18 chapters (or major categories) in this TM (see table 5).

Table 5
Chapters in this TM

Chapter 1: Bioprocessing/Biological Experiments
Chapter 2: Capillarity
Chapter 3: Combustion
Chapter 4: Composites with Gases
Chapter 5: Composites with Solid Particles
Chapter 6: Critical Point Phenomena
Chapter 7: Containerless Processing
Chapter 8: Crystal Growth from Solution
Chapter 9: Crystal Growth from the Melt
Chapter 10: Crystal Growth from the Vapor
Chapter 11: Diffusion
Chapter 12: Fluid Physics
Chapter 13: Liquid Phase Sintering
Chapter 14: Metals and Alloys
Chapter 15: Physical Chemistry/Phase Transition
Chapter 16: Protein Crystal Growth
Chapter 17: Systems Exhibiting a Miscibility Gap
Chapter 18: Technological Experiments

All of the chapters were arranged to illustrate the chronological progression of research in each discipline, while grouping together all the experiments a single principal investigator initiated within that discipline. The experiment series of an investigator are listed together so that the progress and consistency of a particular body of work can be examined. For example, in Chapter 15 (Physical Chemistry/Phase Transition), the first four investigators to perform research in this area were (1) G. H. Otto, (Ice Melting in 1973), (2) J. Ehrhardt (Dispersion Electrolysis in 1977), (3) C. J. Raub (Cathodic Hydrogen Formation in 1977), and (4) G. Mix (Electrochemical Corrosion in 1978). However, J. Ehrhardt had four dispersion electrolysis experiments that were all related to each other (the initial 1977 experiment and then experiments in 1981, 1983, and 1984), and C. J. Raub had two Cathodic Hydrogen Formation Experiments (1977 and 1982). Thus, rather than listing the experiments purely chronologically, dispersing, for example, Ehrhardt's like experiments throughout the chapter, his are grouped together under his first experiment. Thus, the logical progression of Ehrhardt's research in this discipline can be examined as well. The chapter sequence, then is as follows:

Physical Chemistry/Phase Transition

(Listed Primarily Chronologically, but with Investigative Series of Principal Investigators Intact)

Otto, G. H., et al.: Ice Melting (Skylab, 1973)

Ehrhardt, J., et al.: Dispersion Electrolysis (TEXUS 1, 1977)
Ehrhardt, J.: Dispersion Electrolysis (TEXUS 4, 1981)
Ehrhardt, J., et al.: Dispersion Electrolysis (TEXUS 7, 1983)
Ehrhardt, J.: Dispersion Electrolysis (TEXUS 9, 1984)

Raub, C. J., et al.: Cathodic Hydrogen Formation (TEXUS 1, 1977)
Raub, C. J.: Cathodic Hydrogen Formation/Bubble Electrolysis (TEXUS 6, 1982)

Mix, G.: Electrochemical Corrosion (TEXUS 2, 1978)

Even though the data base compilation is broken down into 18 different major research areas (chapters), each chapter contains several different scientific disciplines. Although the titles of some chapters adequately describe the types of experiments contained within that chapter, the titles of four of the chapters are so broad that a more detailed explanation of the many different scientific disciplines contained therein is required.

Chapter 1: Bioprocessing/Biological Experiments

Many different experiments have been performed on low-gravity vehicles that were related to biological or life sciences. However, several were not related to, directly dependent on, or affected by, low-gravity fluid flow. For example, while experiments were performed to observe animal and human reactions to space (e.g., determine if bumble bees can fly in low gravity, study human vestibular system functioning, etc.), these experiments were inappropriate for a data base that was created to analyze and understand fluid response to low-gravity accelerations. Although both the bee and vestibular experiments may have some fluid dynamics dependence, the objectives of the investigators did not center on understanding low-gravity fluid flow.

Initially, it was decided that bioprocessing and biological experiments should not be contained within the data base. Instead, the base would be limited to fluids and materials processing initiatives. However, after reviewing many of the low-gravity bioprocessing and biological experiments, it was clear that several (1) were highly dependent on fluid dynamic response, and (2) had fluid systems similar to those of many materials processing initiatives. For example, during an electrophoresis demonstration, charged particles in solution (biological cells) can be separated according to their net surface charge in the presence of an electric field. On Earth, (1) heat produced by the electric field can initiate and sustain thermal convection in the fluid system and (2) cells of highest density settle to the bottom of the system before separation can occur. In the low-gravity environment, such thermal convection and particle sedimentary effects should be reduced, allowing improved separation of important biological cells. Thus, like many fluids and materials processing experiments (such as those pertaining to systems with miscibility gaps or those involving the solidification of composites with solid particles), electrophoresis experiments seek to determine to what degree convective flow and particle/bubble sedimentation are reduced.

Determining which biological experiments should be included in the data base was significantly difficult to determine. Experiment selection criteria was based on (1) if low-gravity fluid dynamics response was detailed in the post-flight analysis and/or (2) if the biological experiment employed a fluid mechanism similarly observed in nonbiologial experiments within the data base (such as liquid-liquid diffusion, solutally driven convection, etc.).

Experiments within the Bioprocessing/Biological Experiments chapter center around the following disciplines:

1. Attachment of Human Kidney Cells to Microcarrier Beads
2. Blood Storage
3. Cell Secretion (Microtuble Assembly)
4. Collagen Polymerization
5. Electrofusion of Protoplasts
6. Electrophoretic Separation
7. Fibrin Structure Formation/Fibrin Clot Formation
8. Isoelectric Focusing
9. Lymphocyte Proliferation
10. Phase Partitioning
11. Suspension of Submicroscopic Particles (Colloidal Systems)
12. Thin Film Membrane Formation (Formation of Macromolecular Aggregates During a Film Forming Process).

It should be noted that experiments involving protein crystal growth can be found in Chapter 16.

Chapter 2: Capillarity

Many experimental systems are governed by capillary forces, including fluid systems with a free surface, dispersed bubbles, etc. However, not all such experimental systems are incorporated in this chapter. More specifically, the Capillarity chapter contains experiments that did not experience thermally-driven capillary flow. For example, experiments involving the formation and stability of liquid bridges (columns of liquid suspended between two coaxial discs) are included in Chapter 2 while experiments related to the melting and solidification (and resultant surface-tension driven flow) of a free-surface floating zone are not included. Foaming experiments and bubble interaction experiments that did not involve melting and solidification are also included. (Foaming experiments related to metallic melting and solidification can be found in Chapter 4: Composites With Gases).

Experiments within the Capillarity chapter center around the following topics:

1. Capillary Rise and Associated Wetting Kinetics
2. Chemical Reaction Foaming
3. Capillary Wicking
4. Growth and Coalescence of Gas Bubbles Within an Aqueous Solution and Formation of these Bubbles Into a Polyhedral Foam.
5. Liquid Bridge Formation
6. Liquid Bridge Stability
7. Capillary Properties of Liquid Bridges
8. Capillary Waves on Water Surfaces
9. Formation and Properties of Thin Films Formed Between A Contacting Solid and Liquid
10. Freezing of a Water Liquid Bridge
11. Role of Wetting in Fluid Transfer.

Chapter 12: Fluid Physics

Considering that the major goal of the data base was to identify and describe experimental payloads illustrating a dependency on reduced-gravity fluid phenomena, nearly all of the experiments could have been placed in this single chapter. Instead, the chapter contains experiments that had the following major objective: to evaluate and analyze the fluid physics governing the selected experimental system (not study solidification, liquid bridge assembly, protein crystal growth, biotechnology, etc.).

Experiments within the Fluid Physics chapter center around the following topics:

1. Acceleration Disturbances to a Liquid-Vapor Interface
2. Characterization of Rocket Vibration Environment by Measurement of the Mixing of Two Liquids
3. Liquid Transfer/Spreading
4. Liquid Lens Formation
5. Liquid Film Formation
6. Liquid Sloshing (experimental payloads only)
7. Liquid Motion in Partially Filled (Spinning) Containers
8. Experiments Designed to Specifically Examine Heat Flow and Convection (including Thermocapillary and Interfacial Convection)
9. Bubble and Water-Drop Physics (including Acoustic Positioning of Bubbles and Water Drops)
10. Bubble Transport by Chemical Waves
11. Separation of Fluid Phases
12. Thermocapillary Drop/Bubble Motion
13. Powder Flow
14. Cloud Formation
15. Contact and Coalescence of Viscous Bodies
16. Solid/Liquid Collisions
17. Glass Fining
18. Super Fluid Helium Examinations

Chapter 18: Technological Experiments

A great number of fluids and materials experiments performed in the reduced-gravity environment were initiated to:

(1) Demonstrate that activities or procedures habitually performed on Earth (and dependent on fluid flow) could be successfully performed in the reduced-gravity environment (i.e., brazing, soldering, electroplating, tribology, mass measurement)

(2) Evaluate operation of fluid-physics-dependent equipment (i.e., halogen lamps, acoustic positioning hardware, liquid lasers)

(3) Demonstrate new or improved technology (i.e., skin technology, skin casting, production of monodisperse latex particles, superior paper production, space art, heat pipe development), or

(4) Evaluate the space environment (i.e., acceleration measurements, space vacuum).

These experiments were placed in the Technological Experiments chapter.

Experiments within the Technological Experiments chapter center around the following topics:

1. Brazing
2. Soldering
3. Electroplating
4. Skin Technology
5. Slip Casting
6. Tribology
7. Mass Measurement
8. Acoustic Positioning Hardware Evaluation
9. Halogen Lamp and Metal-Halide Arc Lamp Performance
10. Heat Pipes/Thermal Control of Experiments
11. Production of Monodisperse Latex Particles
12. Acceleration Measurement
13. Actual In-Orbit Refueling (see also the Fluid Physics Chapter for related studies)
14. Art
15. Sampling of the Space Vacuum
16. Operation of Liquid Laser
17. Performance of Computer Chips
18. High Performance Liquid Chromatography
19. Paper Formation.

3. Available Indices

This hard-copy version of the data base is accompanied by seven Indices (A to G) that allow readers to locate topics of interest:

Index A:	Key Words
Index B:	Investigators (Principal and Co-Investigators)
Index C:	Payload Type
Index D:	Processing Facility (Including Facility Acronyms)
Index E:	Sample Materials
Index F:	Container Materials
Index G:	Mission

Index A lists (alphabetically) all the words contained within the 600 key words data fields. Key words include (1) the major research area (or category/chapter) of the experiment and (2) a multitude of additional words that describe the experiment (including boundary conditions, governing fluid phenomena, desirable and undesirable fluid characteristics, etc.).

Significant care was taken to select a specific key word string to represent subjects of interest in the data base (and then repeat this specific string throughout all the applicable records). For example the key word string "Fluid Oscillation" was selected and repeated in all applicable records rather than using an array of other similar key words strings throughout individual records (i.e., Oscillating Fluids, Liquid Oscillation, Oscillating Liquids, etc.).

It is important to note that the page numbers listed in Indices A, E , and F do not indicate the actual page on which the key words, sample materials, and crucible materials are located, but instead detail the page on which the experiment summary begins. (Page numbers listed in indices B, C, D, and G do indicate actual page numbers on which information concerning investigators, payload types, processing facilities, and missions appear.)

4. Special Nomenclature/Features in the Data Base

A. Shuttle Mission Nomenclature

Shuttle mission numbers have changed significantly throughout the STS program, and many of the earlier shuttle flights have had multiple designations. For example, for the first 25 shuttle flights (using the nomenclature described in Reference 100), the shuttle had a (sequential) launch number, at least one STS number, and a mission code.[100]

Prior to the actual shuttle flights, missions were assigned an STS number, indicating in what sequence they were manifested. In Reference 100, these were denoted as STS-0_ _ numbers. However, early in the shuttle program, the flights were more commonly identified using the letters "STS" followed by the launch number (e.g., STS-1, STS-2).

The most common mission designations for the first four flights (1981-1983) were the STS numbers that were represented as STS-1 through STS-4. Because the first four missions were considered orbiter flight tests (OFT's), the mission codes for these missions were OFT-1 through OFT-4.

Mission designations for the first four shuttle flights
(most common designation underlined)

Launch No.	STS Number(s) STS-Launch No./Manifest No.	Mission Code
1	STS-1/STS-001	OFT-1
2	STS-2/STS-002	OFT-2
3	STS-3/STS-003	OFT-3
4	STS-4/STS-004	OFT-4

Beginning with the 10th shuttle mission, the assigned shuttle manifest numbers (STS-0_ _) no longer paralleled STS launch numbers. This miss-match resulted because the 10th manifested shuttle mission (STS-010) was canceled. Thus, STS launch No. 10 was actually the flight of the 11th manifested flight (STS-011).[101] Once these manifest numbers were out of sequence with the launch numbers and later, as more manifested STS flights were canceled, the STS manifest numbers deviated further and further from the launch numbers. To add to the confusion, the now more popular mission codes (then represented by a two-digit number followed by a letter, (i.e., STS 41-B)) eventually did not proceed sequentially either.

Although the most common mission designations for flights 5 through 9 were STS-5 through STS-9, the most common designations for flights 10 through 25 were the two-digit/number mission codes.

Mission designations (most common designation underlined)

Launch No.	STS Number(s) STS-Launch No./Manifest No.	Mission Code
5	STS-5/STS-005	31-A
6	STS-6/STS-006	31-B
7	STS-7/STS-007	31-C
8	STS-8/STS-008	31-D
9	STS-9/STS-009	41-A
10	STS-011	41-B
11	STS-013	41-C
12	STS-014	41-D
13	STS-017	41-G
14	STS-019	51-A
15	STS-020	51-C
16	STS-023	51-D
17	STS-024	51-B
18	STS-025	51-G
19	STS-026	51-F
20	STS-027	51-I
21	STS-028	51-J
22	STS-030	61-A
23	STS-031	61-B
24	STS-032	61-C
25	STS-033	51-L

In 1988, (beginning with the 26th launch) STS mission codes were no longer employed. Instead, STS designations were referenced by either the launch number or the STS letters followed by a two-digit manifest number. Once again, the nomenclature was confusing as the STS launch numbers eventually did not parallel shuttle manifest numbers.

Mission designations[83] (most common designation underlined)

Launch No.	STS Number	
26	STS-26	(September 1988)
27	STS-27	
28	STS-29	
29	STS-30	
30	STS-28	
31	STS-34	
32	STS-33	
33	STS-32	
34	STS-36	
35	STS-31	
36	STS-41	
37	STS-38	
38	STS-35	(December 1990)
..	.....	(1991 and beyond)

Although the most common way of representing STS flights 1 to 9 was by the simple STS number STS-1 through STS-9, the data base authors chose to use the STS-001 through STS-009 designations and to retain this STS mission number nomenclature (STS-0__) up to mission No. 25 (known as STS-033). Conversely, STS missions (1988 and beyond) were designated in the data base as the STS letters followed by a two-digit number (e.g., STS-26). These choices of mission nomenclature for the data base were selected to insure that early missions such as STS-033 (1986) would not be confused with say, the later STS-33 mission (1989).

In an effort to aid data base users searching for a particular STS mission, multiple mission designations are presented in the **Mission** field of each experiment record. For example, all experiment entries detail the launch numbers, STS mission manifest numbers, and mission codes (where applicable). In addition, the mission field indicates which shuttle vehicle was employed (Challenger, Discovery, etc.) and if the mission was a Spacelab mission.

A typical Mission field for an STS experiment in the data base that was flown prior to February 1986 is:

Mission: STS Launch #13, STS-017 (STS 41-G, Challenger)

or

Mission: STS Launch #22, STS-030 (STS 61-A, Spacelab D1: Challenger)

A typical Mission field for an STS experiment in the data base flown in 1988 or later is:

Mission: STS Launch #30, STS-32 (Columbia)

B. Sample Materials/Container Materials Nomenclature

Often times, investigators express sample and container materials in terms of chemical formulas. For example, aluminum-indium alloys are expressed as "Al-In alloys". Similar nomenclature was desired for the data base sample-materials-field and container-materials-field. However, if a data base user was interested in locating all experiments that employed indium (In) and searched an electronic form of the data base for this short string of letters (say "..In.."), records that had the following words in the sample materials section would also be singled out: <u>in</u>ert gas, <u>in</u>fluenza virus, <u>in</u>k, <u>in</u>terferon, etc.

Thus, in an effort to insure data base users could search effectively for materials employed, a special nomenclature for these chemical formulas was adopted. Instead of writing only the string AlIn, in the materials field, Al*In* was written (each element symbol being followed by a star (*)). Using this nomenclature, a user searches for the string "In*" to locate experiments employing indium.

When searching for a material of interest (either using an index in this hardcopy version or on a sophisticated (searchable) electronic version of the data base), it would be wise to search for the following character strings: (1) "Al*In*", (2) "In*Al*", (3) "Al*", (4) "In*", (5) "aluminum", and (6) "indium".

In addition, because most data base software packages cannot handle upper and lower case numbers, chemical equations were difficult to reproduce for searching capabilities. Thus, a simplified representation of these equations was adopted. Examples of complicated element strings in the data base are as follows:

(1) If a user was interested in looking for all experiments related to AgCu with Al_2O_3 additions, he could search under "Ag*Cu*Al*O*"

(2) If a user was interested in looking for all experiments employing ammonium chloride (NH_4Cl, he could search under either (1) "ammonium chloride" or (2) "N*H*Cl*"

(3) If a user was looking for all experiments employing cadmium telluride doped with chlorine, he could search under
(1) "cadmium telluride", (2) "chlorine" or (3) "Cd*Te*Cl*".

Sample and crucible materials were often represented in multiple ways (in their respective data fields) to insure data base users could find materials of interest.

C. Quotes in Experiment-Descriptive Summaries

As detailed on p. 58, information that was difficult to understand was often quoted directly from the source and placed into the experiment summaries. Quotes were also used to highlight major experimental results, report critical information related to the experiment, identify experiment anomalies, or to simply restate information as provided in available sources. Quotes (in the data base) are usually followed by a reference number (applicable references are listed at the end of each experiment record) and a page number, i.e., "(1, p. 32)" (which indicates the quote was attained from Reference (1), page 32).

An example of the use of quotes in an experiment summary can be seen in this excerpt from an investigation by H. Wishnow et al. on STS 61-C (quotes highlighted for illustrative purposes only):

Principal Investigator(s): Wishnow, H. (1), Kurtz, E. (2)
Mission: STS Launch #24, STS-032 (STS 61-C, Challenger)
Launch Date/Expt. Date: January 1986

Experiment:
Reaction of Oil Paints on Canvas to Space Travel

The specific objective of this STS-032 experiment was to determine the effects of vibration, temperature change, reduced gravity, and excessive g-stresses on fine arts materials.

Primed and unprimed linen samples, some of which were painted with oil colors using a wide variety of pigments, were employed as test materials. On Earth, the paints were applied using traditional artistic methods, creating actual paintings similar to those which may some day be transported or created on space flights.

The samples were rolled between layers of polyurethane foam and placed in the G-481 Get Away Special (GAS) canister. A thermograph was inserted into the center of the roll to record temperature changes within the can at hourly intervals.

After the 6-day mission, the samples were evaluated by several techniques including X-ray and ultraviolet examination. **The following results were reported (2, p. 115):**

"A. The linen and painted surfaces showed no sign of oxidation.*
B. The surfaces showed no accumulation of foreign substances.
C. The surface layers were fully intact with no evidence of cracking* or flaking* of the pigments.
D. There was no sign of cupping or cleavage.*"

Reportedly, **"Temperature changes within the G. A. S. canister were not recorded due to an error in the programming of the thermograph." (2, p. 115)**

The investigators concluded that no degradation was apparent and that **"...materials of the fine arts can be transported for limited periods of time into space and returned safely." (2, p. 115)**

References/Applicable Publications:

(2) Kurtz, E. and Wishnow, H.: The Transportation of Fine Arts Materials Aboard the Space Shuttle Columbia. In the 1988 Get Away Special Experimenter's Symposium, Cocoa Beach Florida, September 27-29, 1988, NASA CP-3008, pp. 113-119. (post-flight)

D. Notes in Experiment-Descriptive Summaries

As stated on p. 58, notes from the author of the experiment summary (designated in the experiment-descriptive text as "<Note:...>") are included to (1) detail a variety of difficulties encountered in preparing the experiment summary or (2) communicate other useful information to the reader not necessarily directly related to the experiment itself. Notes were most often written to indicate that available information was either (1) conflicting with other sources, (2) difficult to understand, (3) did not follow a logical path, (4) not published in English, and/or (5) not received prior to the release of the TM.

An example of the use of two such notes in an experiment summary can be seen in this excerpt from an investigation by S. Aalto during the MASER 1 mission (<Notes:> are highlighted on the next page for illustrative purposes only):

Principal Investigator(s): Aalto, S. (1)

.

.

Mission: MASER 1

Launch Date/Expt. Date: March 1987

.

.

Experiment:

Thermal Conductivity of Electrically Non-conducting Liquids

.

.

This MASER 1 experiment was designed to measure the thermal conductivity of an electrically non-conducting liquid using a transient hot wire technique.

Two fluid cells within the MASER Fluid Science Module (FSM) were dedicated to the experiment. **<Note: It is unclear if these cells were cylindrical, three-dimensional rectangular, or two-dimensional rectangular, although they appear to have been cylindrical.>** Prior to the flight, each cell was filled with pure ethanol and configured with a 50-micron diameter platinum (hot) wire. The wire stretched down the center, vertical (long) axis of the cell.

<Note: Although it was reported that one cell was "preheated" to 30 $^{\circ}$C and the other to 50 $^{\circ}$C, it is unclear if this heating was initiated prior to the start of the low-gravity phase or after the low-gravity phase had been obtained. (It appears that the liquid in each cell was warmed by an outer, concentric cylindrical heater (the same length as the cell)).>

During the experiment, a constant current was passed through the wires. Thermal conductivity measurements were derived from voltage drops which occurred across the 100-mm measuring length of the wire. The temperature in the liquid was measured by two thermocouples located near the wire.

.

.

.

E. Brief Notes Following References

Many references detailed in each of the experiment records have brief notes following them to (1) alert the reader that the document was published in a foreign language, (2) indicate that the text discusses either preflight or post-flight issues, (3) identify what mission results are discussed therein, or (4) indicate that something other than results or preflight information is discussed (e.g., processing facility design, related acceleration measurements, etc.). Examples of such reference notes can be seen in the following excerpt from E. G. Lierke's TEXUS 14b experiment (with notes highlighted and underlined for illustrative purposes only):

Principal Investigator(s): Lierke, E. G. (1)
Mission: TEXUS 14b
Launch Date/Expt. Date: May 1987

Experiment:
Acoustic Positioning

.
. (Experiment Summary Omitted Here)
.
.

References/Applicable Publications:

(1) Lierke, E. G., Grossbach, R., Flogel, K., and Clancy, P.: Acoustic Positioning for Space Processing of Materials Science Samples in Mirror Furnaces. Symposium in Industrial Activity in Space, Stressa, Italy, May 2-4, 1984, Proceedings, Paris, Eurospace, 1984, pp. 116-126. **(preflight; TEXUS 1 results)**

(2) Lierke, E. G. and Grossbach, R.: Akustische Positionierung. In BMFT/DFVLR TEXUS 13-16 Abschlussbericht 1988, pp. 90-93. **(in German; post-flight)**

(3) Experimentmodul TEM 02-2. In BMFT TEXUS 13-16 Abschlussbericht 1988, pp. 90-93. **(in German; post-flight)**

(4) Lierke, E. G., Grossbach, R., Flögel, and Clancy, P.: Acoustic Positioning for Space Processing of Materials Science Samples in Mirror Furnace. In Proceedings of the 1983 Ultrasonic Symposium, October 31 - November 1-3, 1983, pp. 1129-1139. **(preflight; theoretical discussion; TEXUS 1 results; TEXUS 9 proposal)**

(5) Clancy, P. F., Lierke, E. G., Grossbach, R., and Heide, W. M.: Electrostatic and Acoustic Instrumentation for Material Science Processing in Space. Acta Astronautica, Vol. 7, 1980, pp. 877-891. **(preflight; discusses experiment apparatus)**

5. Naming the Data Base

When the compilation was first created, it was called the Fluids And Materials Experiments (FAME) data base. At the request of NASA headquarters, the name was changed to indicate that the base documented reduced-gravity experiments. Thus, the compilation is currently known as the Microgravity Research Experiments (MICREX) data base.

VIII. Electronic Manipulation and Access of the Data Base

1. In-House Manipulation of Data (PC Software)

Initially, all of the data pertaining to fluids and materials processing experiments was stored in a personal computer using an off-the shelf (commercial) data base software package called REFLEX (by Borland Co.). Originally, this software was an acceptable choice for electronically manipulating the in-house version of the MSFC data base. However, when it was determined that (1) extensive electronic writing/editing of experiment summaries was necessary and (2) hardcopy (publication-quality) retrieval of experimental records was desired, REFLEX could not be easily employed to obtain these tasks. Instead, the REFLEX data files were transferred into files that could be edited and printed with a word processor. Eventually, the contents of the word processor files were transferred into another PC commercial data base software package called 4th Dimension (by ACIUS, Inc.). The current MSFC (in-house) working version of the data base is still manipulated via this software.

2. World-Wide Web Electronic Access to MICREX

An electronic version of the MICREX data base is available on-line and can be accessed via the World Wide Web (WWW) using various Hypertext Markup Language browsers such as AIR Mosaic, NCSA Mosaic, Mosaic Netscape, or Cello (fig. 26). MICREX can be directly accessed with the following address:

http://otis.msfc.nasa.gov/fame/Fame.html

This WWW version, which currently contains information on over 800 fluids and materials processing experiments (the 600 contained in this TM and over 200 more-recent experiments), is updated periodically from the MSFC PC working version of MICREX. These periodic updates are performed to place information pertaining to new experiments into the compilation or to expand information on experiments already within the data base.

Currently, the WWW version of the data base contains information on experiments performed during the following programs:

(1) U.S. Mercury, Apollo, Skylab, and Apollo-Soyuz (1962-1975)
(2) U.S. Space Processing Applications Rocket (SPAR) sounding rocket (1975-1983)
(3) U.S. Space Shuttle (1982-1994)
(4) U.S. Consort sounding rocket (1989-1992)

(5) German Technologische Experimente unter Schwerelosigkeit (TEXUS) sounding rocket (1977-1991)
(6) Japanese TT-500A sounding rocket (1980-1983)
(7) Swedish Materials Science Experiment Rocket (MASER) (1987-1988).

A breakdown of the number of experiments performed during each program (as of April 1995) is presented in table 6.

Table 6
Number of Experiments (by Mission)
Contained in the WWW Version of Micrex

Mercury and Apollo		11
Skylab		46
Apollo-Soyuz Test Project		10
U.S. Space Shuttle		422
Spacelab Missions		
Spacelab 1 (1983)	36	
Spacelab 2 (1985)	3	
Spacelab 3 (1985)	5	
Spacelab D1 (1985)	49	
Spacelab D2 (1993)	41	
Spacelab J (1992)	40	
USML-1 (1992)	37	
IML-1 (1992)	23	
IML-2 (1994)	18	
SLS-1 (1991)	13	
Middeck	62	
Payload Bay *	95	
SPAR		46
TEXUS		209
TT-500A		14
MASER		15
Consort		56
		829

* Excluding Spacelab Missions, but including (1) GAS Cans and MAUS cans, (2) Payload Bay Carrier Systems (e.g., MEA, MSL, USMP), (3) Free Flying Satellites deployed from the Payload Bay (e.g., LDEF and SPAS).

---

3. Searching Capabilities/Limitations of the MICREX Data Base on the WWW

The WWW electronic version of MICREX has some limited searching capabilities. Users can obtain listings (called indexes) of experiments by subject, mission/payload-type, or principal investigator. After an index type is selected and listed, users scroll down the listing and select (click on) an experiment record of interest. Experiment summaries (similar to the ones in this TM) are then displayed for review.

The subject index allows users to see the data much like it is arranged in this TM. Experiments are grouped together (chronologically) by subject (i.e., categories). These subjects are essentially the same as the chapters listed in this TM:

Biotechnology
Capillarity
Combustion
Composites with Gases
Composites with Solid Particles
Critical Point Phenomena
Containerless Processing
Crystal Growth from Solution
Crystal Growth from the Melt
Crystal Growth from the Vapor
Diffusion
Fluid Physics
Liquid Phase Sintering
Metals and Alloys
Physical Chemistry/Phase Transition
Protein Crystal Growth
Systems Exhibiting a Miscibility Gap
Technological Experiments
Miscellaneous Experiments

The mission/payload-type index allows users to list experiments of a certain payload type (such as all Gas Can Experiments). The listings are chronological by mission. The following payload types can be selected and listed:
Long Duration Exposure Facility (LDEF)
Mercury
Skylab
Sounding Rocket
Get Away Special (GAS)
Middeck
Payload Bay
Spacelab
High School and College Experiments

The principal investigator index groups experiments alphabetically by the first principal investigator listed in the experiment record. For example, if the principal investigators of an experiment were both Grodzka and Facemire, (and Grodzka was listed first in the data record) the experiment information would be found alphabetically in the listing under "G". Unfortunately, this same experiment record is also not listed alphabetically under "F" for Facemire, nor can the user search for all of the experiments Facemire has been involved in as a principal or co-investigator. Likewise, the user can not search for all the experiments performed by any particular principal or co-investigator; he can only see a summary of experiments arranged alphabetically by the first investigator listed in the record.

Other searching options of the WWW version of MICREX are not yet available. For example, although each experiment record has a detailed key words section (which was very carefully prepared to guide users to experiments of interest by (1) category (subject), (2) governing fluid phenomena, (3) desirable and undesirable fluid characteristics, etc.), this field cannot currently be searched on the electronic version. If such a searching capability becomes available, the indices contained in this hardcopy TM could be employed to enable users to search quickly for subjects of interest. This hardcopy version (with indices) does give readers the option of searching for items of interest.

For most purposes, effective searching through the 800 fluids and materials processing experiments currently residing on the electronic version of the data base would require sophisticated computational assistance. In the ideal situation, users could group experiments together based on either one or a multitude of criteria including: (1) selected key words, (2) similar materials processed, (3) experimental methods employed, (4) principal investigators involved, etc. As stated above, this capability does not currently exist on the WWW MICREX version.

4. Possible Additional Networking of the Data/Possible Enhanced Search Capabilities

It is expected that the electronic version of MICREX will also be made available on either the NASA Research Connection (ReCon) scientific information system or the NASA Aerospace Research Information Network (ARIN). Because both of these systems have sophisticated searching capabilities (almost any data field can be effectively searched), manipulation of the MICREX information would be greatly enhanced. Placement of MICREX on ReCon or ARIN would insure that the data base is readily available to all NASA employees as well as a multitude of scientific communities that already employ these systems.

5. Draft of Data Base on MSAMS

Presently, an old draft of the data base (containing information on the initial 600 experiments placed in MICREX), is also available on-line through NASA Langely's Microgravity Science Applications System (MSAMS). Access to the data base using MSAMS is free of charge and readily available using either INTERNET or a modem. To obtain a password and access instructions, call Vivian Lewis, CTA, Incorporated, (804) 827-6701.

6. MICREX Data Availability Via ESA's MGDB

Presently, some of the MICREX data resides in the European Space Agency's (ESA's) MicroGravity DataBase (MGDB). A prototype of the fully searchable MGDB is now available over the WWW. The address is:

http:///www.esrin.esa.it/htdocs/mgdb/mgdbhome.html

IX. References:

(1) Otto, E. W.: Static and Dynamic Behavior of the Liquid-Vapor Interface During Weightlessness. Chemical Engineering Progress Symposium Series, Vol. 62, No. 61, 1966, pp. 158-177.

(2) Aydelott, J. C., Corpas, E. L. and Gruber, R. P.: Comparison of Pressure Rise in a Hydrogen Dewar for Homogeneous, Normal-Gravity Quiescent, and Zero-Gravity Conditions- Fight 9. NASA TM X-1052, February 1965.

(3) Naumann, R. J.: Historical Development. NASA MSFC Space Science Laboratory Preprint Series No. 85-152, September 1985.

(4) Ramachandran, N. and Winter, C. A.: Effects of g-Jitter and Marangoni Convection on Float Zones. Journal of Spacecraft and Rockets, Vol. 29, No. 4, July-August 1992, pp. 514-522.

(5) Naumann, R. J. and Herring, H. W.: Materials Processing in Space: Early Experiments. NASA SP-443, 1980.

(6) Salzman, J. A.: Microgravity Research Facilities at the NASA Lewis Research Center. In: In Space 87, October 13-14, 1987, Japan Space Utilization Promotion Center (JSUP).

(7) Lekan, J., Neumann, E. S., and Sotos, R. G.: Capabilities and Constraints of NASA's Ground-Based Reduced Gravity Facilities. Second International Microgravity Combustion Workshop, NASA Lewis Research Center, Cleveland, Ohio, September 15-17, 1992.

(8) Microgravity Combustion Science: Progress, Plans, and Opportunities. NASA TM 105410, April 1992.

(9) Malmejac, Y. and Walter, H. U.: Materials Science Research with Sounding Rockets. ESA, MAT(79)5, rev. 1, Paris, January 1980.

(10) Hammer, L. R.: Aeronautical Systems Division Studies in Weightlessness: 1959-1960. WADD Technical Report 60-715, March 1962, United States Air Force.

(11) Personal Communication with Don Griggs (retired, NASA Johnson Space Center), concerning aircraft used as reduced gravity Test Beds, March 1994.

(12) NASA Johnson Space Center Reduced-Gravity Program. Brochure describing the KC-135a reduced-gravity facility. Available from the Reduced Gravity Office, Mail Code CC3, Houston, TX 77058.

(13) White, L. G.: JSC Reduced Gravity Program User's Guide. JSC-22803, July 1991.

(14) Lekan, J.: Microgravity Research in NASA Ground-Based Facilities. NASA TM-101397, 1989.

(15) Man/Systems Simulation User's Guide; KC-135 Aircraft & Neutral Buoyancy Simulator. NASA Marshall Space Flight Center, November 1985, MSFC-DOC-1263.

(16) Microgravity... a new tool for basic and applied research in space. NASA Microgravity Science and Applications Division, Office of Space Science and Applications, EP-212.

(17) Yost, V. H.: Experimental Studies of Manufacturing Processes Performed in Zero-G. In Research Achievements Review, Volume 4, Report #7, Process Engineering at Marshall Space Flight Center, NASA TM X-64723, February 1973, pp. 67-106.

(18) Curreri, P. A. (editor): Materials Science on Parabolic Aircraft. NASA Technical Memorandum 4456, March 1993.

(19) Accessing Space. NASA NP-118, September 1988.

(20) Hill, M. E. and O'Malley, T. F.: A Summary of Existing and Planned Experiment Hardware for Low-Gravity Fluids Research. AIAA 29th Aerospace Sciences Meeting, January 7-10, 1991, Reno, Nevada, AIAA Paper #91-0777.

(21) Petrash, D. A., Zappa, R. F., and Otto, E. W.: Experimental Study of the Effects of Weightlessness on the Configuration of Mercury and Alcohol in Spherical Tanks. NASA TN D-1197, 1962.

(22) Personal Communication with Buddy Yates concerning early MSFC materials processing drop tower experiments, March 1994.

(23) 11. Saturn Test Stand Used for 'Weightless' Experiments. NASA News, June 7, 1974, release No. 74-100.

(24) McAnelly, W. B. and Covington, S. S.: Low-Gravity Fluid Mechanics Drop Tower Facility. NASA TMX-53817, February 1969.

(25) Personal communication with Leon Hastings (NASA MSFC) concerning first experiments performed in the MSFC drop tower, March 1994.

(26) Drop Tower and Drop Tube Facilities (Reference obtained from Mike Wright, Historian, MSFC).

(27) Personal Communication with L. L. Lacy (MSFC drop tube designer), September 1995.

(28) Robinson, M. B., Bayuzick, R. J., and Hofmeister, W. H.: Undercooling Studies on Nb-Pt and Nb-Si Alloys Using the 105 Meter Drop Tube. Adv. Space Res. Vol. 8, No. 12, pp. (12)321-(12)330, 1988.

(29) NASA Drop Tube: A Tool for Low Gravity Research. Brochure available through NASA Marshall Space Flight Center, CMPS 302.

(30) Information supplied by Mike Robinson and Tom Rathz, MSFC, September 1995 and April 1996.

(31) Hofmeister, W. H., Robinson, M. B., and Bayuzick, R. J.: Undercooling of Pure Metals in a Containerless, Microgravity Environment. Appl. Phys. Lett. 49(20), November 17, 1986, pp. 1342-1344.

(32) Rathz, T. J. and Robinson, M. B.: The NASA/Marshall Space Flight Center Drop Tube User's Manual. NASA TM-100392, March 1990.

(33) Knoll, R. H., Smolak, G. R. and Nunamaker, R. R.: Weightlessness Experiments with Liquid Hydrogen in Aerobee Sounding Rockets; Uniform Radiant Heat Addition-Flight 1. NASA TM X-484, June 1962.

(34) McArdle, J. G., Dillion, R. C., and Altmos, D. A.: Weightlessness Experiments with Liquid Hydrogen in Aerobee Sounding Rockets; Uniform Radiant Head Addition-Flight 2. NASA TM X-718, December 1962.

(35) Adelott, J. C., Corpas, E. L., and Gruber, R. P.: Comparison of Pressure Rise in a Hydrogen Dewar for Homogeneous, Normal-Gravity Quiescent, and Zero-Gravity Conditions-Flight 7. NASA TM X-1006, September 1964.

(36) Personal communication with K. L. Abdalla (retired NASA Lewis Research Center) concerning Aerobee and Atlas rocket flights, 1994.

(37) Abdalla, K. L., Frysinger, T. C., and Andracchio, C. R.: Pressure-Rise Characteristics for a Liquid-Hydrogen Dewar for Homogeneous, Normal-Gravity Quiescent and Zero-Gravity Tests. NASA TM X-1134, September 1965.

(38) Yates, I. C. and Yost, V. H.: Research Rocket Tests RR-1 (Black Brant VC) and RR-2 (Aerobee 170A): Investigations of the Stability of Bubbles in Plain and Fiber-Reinforced Metal Melted and Solidified in a Near-Zero-g Environment. NASA TM X-64665.

(39) Space Processing Applications Rocket (SPAR) Project, SPAR X Final Report. NASA TM-86548, July 1986.

(40) Space Processing Applications Rocket Project, SPAR I Final Report. NASA TM X-3458, December 1976.

(41) Space Processing Applications Rocket Project, SPAR II Final Report. NASA TM-78125, 1977.

(42) Kajiwara, K., Matsuda, T., Shibato, Y., Masuda, T., and Akimoto, T.: Results of Japanese Space Processing Experiments Using the TT-500A Rocket. 34th Congress of the International Astronautical Federation, October 10-15, 1983, Budapest, Hungary, IAF Paper #83-157, 8 pp.

(43) Ara, T.: Japan Microgravity Project. In 2nd Joint Japan-Germany-ESA Symposium on Microgravity Research, Tokyo, March 25-26, 1985, pp. 57-60.

(44) Saito, S. and Sawaoka, A.: Review of Japanese Material Processing Tests in Space. In Materials Processing in Space, proceedings of a special conference, Cincinnati, Ohio, May 4-5, 1982, pp. 55-68.

(45) Personal Communication with Y. Yamaura, NASDA Liaison at NASA Marshall Space Flight Center (1987).

(46) Shibato, Y., Watanabe, A., and Akimoto, T.: Japanese Space Processing Experiments Using Sounding Rockets. 30th IAF, Munich, Germany, September 1979, IAF Paper #79-60, 9 pp.

(47) Sawaoka, A.: Japanese Effort Towards Materials Processing in Space. In Manufacturing in Space, proceedings of the winter annual meeting, Boston, Massachusetts, November 13-18, 1983, ASME, pp. 33-42.

(48) Present Situation of Microgravity Research and Future Programs in Japan. In 2nd Joint Japan-Germany-ESA Symposium on Microgravity Research, Tokyo, March 25-26, 1985, pp. 39-44.

(49) Summary Review of Sounding Rocket Experiments in Fluid Science and Materials Sciences: TEXUS 1 to 20, MASER 1 and 2. ESA SP-1132, February 1991.

(50) Shuttle/Spacelab Utilization. Final Report, Project TEXUS II, 1978, DFVLR.

(51) TEXUS 13-16 Abschlussbericht 1988.

(52) Anton, H. S. and Sahm, P. R.: Overview of German Microgravity Projects. In 2nd Joint Japan-Germany-ESA Symposium on Microgravity Research, Summary Report, Tokyo, March 25-26, 1985.

(53) MBB Flight Opportunities and Facilities for Microgravity Research and Applications. Space Systems Group, Orbital Systems and Launcher Division.

(54) MASER and Its Effectiveness and Experimental Results. Information supplied to C. Winter by J. Zaar.

(55) A brochure entitled: "Microgravity," issued by the Swedish Space Corporation and supplied to C. Winter by J. Zaar.

(56) Zaar, J. and Dreier, L.: MASER 2 Final Report. RMLO/1-7, Swedish Space Corporation.

(57) Lundquist, C. A. and Wessling, F. C.: Microgravity Investigations on Suborbital Rockets. 40th Congress of the International Astronautical Federation, October 7-12, 1989, Málaga, Spain, IAF-89-425.

(58) Wessling, F. C. and Maybee, G. W.: Consort 3 Results. Journal of Spacecraft and Rockets, Vol. 31, No. 1, pp. 39-47, January-February 1994.

(59) Wessling, F. C. and Lundquist, C. A.: Consort 1 Flight Results- A Synopsis. 40th Congress of the International Astronautical Federation, October 7-12, 1989, Málaga, Spain, IAF-89-439.

(60) Information received from Dr. Francis Wessling, UAH, 1995, detailing Consort rocket despin sequence and low-gravity flight timeline.

(61) Petrash, D. A., Nelson, T. M., and Otto, E. W.: A Study of the Effect of Surface Energy on the Liquid-Vapor Interface Configuration During Weightlessness. NASA TN D-1582, 1962.

(62) Petrash, D. A., Nussle, R. C., and Otto, E. W.: Effect of the Acceleration Disturbances Encountered in the MA-7 Spacecraft on the Liquid-Vapor Interface in a Baffled Tank During Weightlessness. NASA TN D-1577, 1962.

(63) MSFC Skylab Mission Report-Saturn Workshop. NASA TM X-64814, October 1974, p. 1-1.

(64) Skylab, a Guidebook. NASA EP-107, 1973.

(65) MSFC Skylab Mission Report-Saturn Workshop. NASA TM X-64814, October 1974, p. 1-2.

(66) "The Skylab Missions." Marshall Star Newspaper, May 11, 1988.

(67) Bannister, T. C.: Skylab III and IV Science Demonstrations Preliminary Report. NASA TM X-64835.

(68) Science Demonstrations. In MSFC Skylab Corollary Experiment Systems Mission Evaluation, NASA TM X-64820, September 1974.

(69) Apollo-Soyuz Pamphlet No. 8: Zero-G Technology. October 1977.

(70) Apollo-Soyuz Pamphlet No. 9: General Science. October 1977.

(71) Spacelab News Reference, Marshall Space Flight Center, 14M983.

(72) STS Investigators' Guide. NASA MSFC.

(73) Information received from J. Jackson, Johnson Space Center, Flight Crew Support Division, to C. Winter, 1995.

(74) STS-004 Press Kit

(75) Shuttle Student Involvement Program (SSIP) Final Reports of Experiments Flown. NASA/JSC Internal Note, JSC 24005, October 20, 1989.

(76) Everyone's a Winner with SSIP! National Science Teachers Association/NASA Office of Human Resources and Education (Education Division) brochure, EP-317, June 1994.

(77) Spacelab. NASA EP-165.

(78) NASA Facts, Goddard Space Flight Center, NASA's Get Away Specials.

(79) Shuttle Small Payloads: Capabilities. NASA Goddard Space Flight Center, Shuttle Small Payloads Project, 1992.

(80) Get Away Special... the first ten years. Goddard Space Flight Center, Special Payloads Division, 1989.

(81) Get Away Special (GAS) Small Self-Contained Payloads: Experimenter Handbook. NASA Goddard Space Flight Center, Special Payloads Division, 1991.

(82) NASA STS-7, Seventh Space Shuttle Mission Press Kit, June 1983.

(83) Space Shuttle Mission Chronology, 1981-1991. KSC Release No. 12-92, May 1992.

(84) Feazel, M.: Shuttle Will Fully Deploy German Pallet. Aviation Week & Space Technology, February 21, 1983.

(85) Pfannerstill, J.: Challenger's Return to Space. Spaceflight, 1984.

(86) NASA 41-B Tenth Space Shuttle Mission Press Kit, February 1984.

(87) Davidts, D.: The Shuttle Pallet Satellite System. Journal of the Astronautical Sciences, Vol. XXVIII, No. 3, July-September 1980, pp. 283-298.

(88) Koelle, D. E. and Davidts, D.: SPAS- The Shuttle Dedicated Pallet Satellite Concept and its Applications. 1978 Goddard Memorial Symposium, International Forum on Shuttle/Spacelab Utilization, Washington, D. C., March 8-10, 1978.

(89) The Long Duration Exposure Facility (LDEF) Mission 1 Experiments, NASA SP-473.

(90) First LDEF Post-Retrieval Symposium Abstracts, Kissimmee, Florida, June 2-8, 1991, NASA CP-10072, p. 99.

(91) OSTA-2 Payload. Spacelab Projects Office, December 1982.

(92) Marshall Space Flight Center STS-7 Support Information Kit.

(93) Materials Processing Experiments in Space; MEA-A2 Payload. Application Payload Projects, NASA MSFC.

(94) Personal communication with Richard Valentine, formerly NASA MSFC, 1995.

(95) Materials Processing Experiments in Space; MSL-2 Payload. Application Payload Projects, NASA MSFC.

(96) United States Microgravity Payload. NASA Marshall Space Flight Center Projects Office brochure.

(97) Schafer, C. F.: Liquid Mixing Experiment. In Space Processing Applications Rocket Project, SPAR I Final Report, NASA TM X-3458, pp. IV-1 - IV-37, December 1976.

(98) Personal communication from GAS can Investigator to C. Winter, 1987.

(99) Concerning Support to a Data Base Documenting the NASA/MSFC Fluids and Materials Processing Experiments in Space. Final Report to University of Alabama at Birmingham under sub-contract to NASA/MSFC Contract NAS8-36611, October 1989 by the Center for Space and Advanced Technology, Huntsville. (Performance Period March 1, 1989-October 31, 1989.)

(100) Ridenoure, R. W.: Get Away Special (GAS) Mission History. Version F, November 1986.

(101) Personal Communication with Marc Raymond, JPL Laboratories, 1995.

(102) Curreri, P. and Reiss, D.: Preliminary Flight Results from the Second U.S. Microgravity Payload (USMP-2). In Spacebound '94, proceedings, Canadian Space Agency, May 19-20, 1994, Montreal, Canada, p. 13.

X. Appendix

Center for Space and Advanced Technology
Technical Center

4/15/88

Dear Dr.

A compilation of information concerning all known fluids and materials processing experiments performed in the space environment is being assembled by the Fluid Dynamics Branch of the Marshall Space Flight Center (NASA). The Center for Space and Advanced Technology (CSAT) is assisting NASA in this compilation. The first version of the data base will profile experiments giving name, location and affiliation, experiment title, applicable publications etc and also provide a brief experiment description. Currently the data base identifies approximately 600 separate experiments which have flown on Apollo, Skylab, SPAR, TEXUS, MASER, Salyut/Soyuz and Space Shuttle missions. NASA plans to publish this compilation this year as a resource for use by the scientific community. Since most of this information has been obtained from the open literature where there are different styles and purposes for publication, fitting the information into one format has, in some cases, been a challenge.

The Fluid Dynamics Branch of MSFC/NASA and CSAT would like to assure that your research efforts are accurately included in the data base. The attached initial data sheet is offered for your review. Please comment on any discrepancies and provide any additional information, such as additional Co Investigators, etc. If additional publications are available which describe your experimental efforts associated with the space research, please provide references to these articles. Please list all applicable articles, regardless of the language in which they are written. If possible, please send a copy of these publications.

An example of a typical entry into the data base is also attached for your convenience. This example represents information concerning the Geophysical Fluid Flow Cell flown on Spacelab 3 by J. E. Hart. There are two short paragraphs included that aid in the description of the experiment. One is a summary of the experiment. The second concerns application(s) of the materials processed or an explanation of why the space environment is important for such research.

In addition to verifying the information concerning your space experiment, please provide the two short paragraphs described on the previous page for inclusion in the data base. The data base entry form allows up to 18 typewritten lines for the summary and 6 typewritten lines for the applications paragraph. Because of the many requests for this type of information from the scientific community, including current and future investigators, we plan to publish the data base as soon as appropriate, and we certainly desire that your experiment be listed accurately. All responses must be received by May 1, 1988. We believe that this publication will be a valuable reference for academia, industry and government. Thank you for your assistance.

Sincerely

John R. Williams
Vice President

500 Boulevard South, Suite 104 • Huntsville, Alabama 35802 • (205) 883-5773

WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

June 15, 1993

Dear Dr.

NASA Marshall Space Flight Center and Wyle Laboratories have compiled a data base containing experiments performed on (1) U. S. Manned space vehicles, (2) payloads deployed from U. S. Manned space vehicles, and (3) all domestic and international sounding rocket programs (excluding those of the U. S. S. R. and China). Approximately 600 of the experiments from the data base will soon be released in hard copy format as a NASA Technical Memorandum (TM) titled "Fluids and Materials Processing Experiments (FAME) Data Base". The complete data base, regularly updated as experiments are flown, is available through NASA Langley's Microgravity Science Applications Management System (MSAMS) Data Base and will be available through the European Space Agency's (ESA's) Micro Gravity Data Base (MGDB). Both MSAMS and MGDB can be accessed through the INTERNET computer network.

To insure that research efforts are accurately represented, your experiment entries, which are to be included in the NASA TM, are enclosed. We ask that you (1) review this information, (2) indicate any discrepancies or inaccuracies within these records, and/or (3) add any additional information where applicable. Please add recently released publications, which directly apply to your experiment, to the REFERENCES/APPLICABLE PUBLICATIONS section. If the EXPERIMENT SUMMARY section needs to be expanded, please add any additional information. We do not plan on adding any additional paragraphs to the EXPERIMENT SUMMARY at this time, unless you provide this information. We have also enclosed a list of data base chapters and have indicated under which chapter your experiments are included. Please indicate if you would like to move your experiments to a different chapter.

All changes and corrections received prior to August 6, 1993 will be incorporated into the NASA TM. Any changes or corrections received after this date will be incorporated into the computerized versions of the data base, but not in this release of the NASA TM. If the experiment records are not returned, we will assume that all information contained in your experiment records is correct and current. This is the second time at least one of the identified Principal Investigators has been contacted in connection with the verification of this data. The previous request for information was either requested by the Center for Space and Advanced Technology (CSAT) or myself.

If you have any questions or comments, please feel free to call me at (205) 544-6904. Thank you for your cooperation.

Sincerely,

Jonathan C. Jones

7800 Governors Drive • P.O. Box 077777 • Huntsville, Alabama 35807-7777 • (205) 837-4411

Typical Summary Sent to Investigators (Complete with Additional Questions Section)

Principal Investigator(s): Schafer, C. F. (1)
Co-Investigator(s): None
Affiliation(s): (1) National Aeronautics and Space Administration (NASA), Marshall Space Flight Center (MSFC), Huntsville, Alabama

Experiment Origin: USA
Mission: SPAR 1
Launch Date/Expt. Date: December 1975
Launched From: White Sands Missile Range, New Mexico
Payload Type: Sounding Rocket Experiment
Processing Facility: Temperature Control Unit (TCU) furnace (heaters, sample cartridges, water quench system, and sample monitoring thermistors)
Builder of Processing Facility: NASA Marshall Space Flight Center, Huntsville, Alabama

Experiment:
Characterization of Rocket Vibration Environment by Measurement of the Mixing of Two Liquids (74-18)

This SPAR 1 experiment was the first in a series of investigations designed by Schafer et al. to illustrate the nature of the SPAR rocket acceleration environment and its effect on diffusion-controlled fluid systems.

Prior to the SPAR mission, three 0.6 cm cylindrical samples were prepared. Each of these prepared samples consisted of a section of pure indium joined to a similarly-sized section of 80 wt% indium-20 wt% lead. The density differences between the two sections were selected to allow convective mixing to occur if sufficient residual gravity was present when the materials were (later) molten.

Each sample was placed within a separate heater within the experiment Thermal Control Unit (TCU). The three sample/heater assemblies were configured such that each was aligned differently to the rocket longitudinal axis and onboard accelerometer axes when the TCU was mounted in the SPAR rocket.

During the SPAR 1 experiment, the samples were melted and solidified during the low-gravity coasting phase of the mission. Reportedly, the experiment sequence was as follows: (1) 45 seconds after launch, sample heating was initiated, (2) 225 seconds after launch, sample heating was terminated, and (3) 345 seconds after launch, sample quench was initiated.

Inspection of the flight data and/or the returned TCU payload indicated that (1) the experiment was performed as scheduled, (2) the samples were processed with the expected thermal profile, and (3) the quench system performed as expected.

Post-flight, the three In-(In-Pb) interfaces were examined to determine the degree of mixing that had occurred in each of the samples. Reportedly, the sample "...(oriented parallel to the payload longitudinal axis) experienced interface motion near that ...expected from diffusion... the sample (aligned parallel to the accelerometer x-axis) experienced a small amount of interface motion... which might be slightly more than that expected by diffusion... and the sample (aligned parallel to the accelerometer y-axis) experienced flow down one side of the container." (1, p. IV-27)

Both experimental and computational correlation of fluid motion with acceleration environment was performed. It was observed that (1) "...the magnitudes of the flow experienced by the three samples... are consistent with the acceleration arising from the rotation of the payload about its longitudinal axis...."(1, p. IV-36), and (2) the level of this acceleration is of the order of 10^{-5} g or less. Thus it was concluded that while the residual accelerations aboard SPAR are very low and the vehicle provides a good platform for experiments requiring up to 5 minutes of low-g time, convective fluid motion can occur at these low-g levels. It was recommended that computations to estimate levels of effective gravity for which convective flows become significant be performed for a given experimental configuration.

Key Words: Fluid Physics, Melt and Solidification, Binary Systems, Alloys, Quench Process, Convection, Density Difference, Liquid Mixing, Liquid/Liquid Interface, Diffusion, Rotation of Payload, Acceleration Effects, Acceleration Measurement

Number of Samples: three
Sample Materials: First section: pure indium; second section: 80 wt% In-20 wt% Pb
(In*Pb*)
Container Materials: aluminum
(Al*)

Experiment/Material Applications:
It is expected that the low gravity environment will reduce convective flow in systems with density gradients. This experiment illustrates the need to characterize the acceleration environment and to consider the effects of possible fluid motions even at low acceleration levels.

The In/In-Pb system was chosen for several reasons. First, not only could it be used illustrate the mixing behavior of two fluids of differing density, but it was also expected to yield results which could be interpreted as relevant to other experiments involving differing density fluids. Second, its "...kinematic viscosity is in the range of kinematic viscosities of materials of interest to other investigators (e.g. liquid metals). This follows from the fact that for a fixed geometry, the kinematic viscosity of a fluid is a fundamental parameter for governing flow due to accelerations which act through density differences." (1, p. IV-4) "Thirdly, the materials chosen for sample preparation were selected so as to minimize spurious flow effects." (1, p. IV-4)

References/Applicable Publications:
(1) Schafer, C. F.: Liquid Mixing Experiment. In Space Processing Applications Rocket Project, SPAR I Final Report, NASA TM X-3458, pp. IV-1 - IV-37, December 1976. (post-flight)

(2) Schafer, C. F. and Fichtl, G. H.: SPAR 1 Liquid Mixing Experiment. 15th AIAA Aerospace Sciences Meeting, Los Angeles, California, January 24-26, 1977, 8 pp. (post-flight)

(3) Toth, S. and Frayman, M.: Measurement of Acceleration Forces Experienced by Space Processing Applications. Goddard Space Flight Center, Contract No. NAS5-23438, Mod. 23, ORI, Inc., Technical Report 1308, March 1978. (acceleration measurements; SPAR 1-4)

(4) Liquid Mixing Experiments. In Descriptions of Space Processing Applications Rocket (SPAR) Experiments, Edited by R. J. Naumann, NASA TM-78217, January 1979, pp. 11-12. (post-flight)

(5) Input received from Principal Investigator C. F. Schafer, August 1993.

Contact(s):

Charles F. Schafer
EP55
NASA Marshall Space Flight Center, AL 35812

Typical Summary Sent to Investigators, Cont.

Additional Questions:

Should anyone be listed as a Co-Investigator? If so, please indicate (1) their name, (2) where they worked at the time of the mission, and (3) where they work now.

Additional information has been added to this summary since you received it for review the first time.

XI. Figures

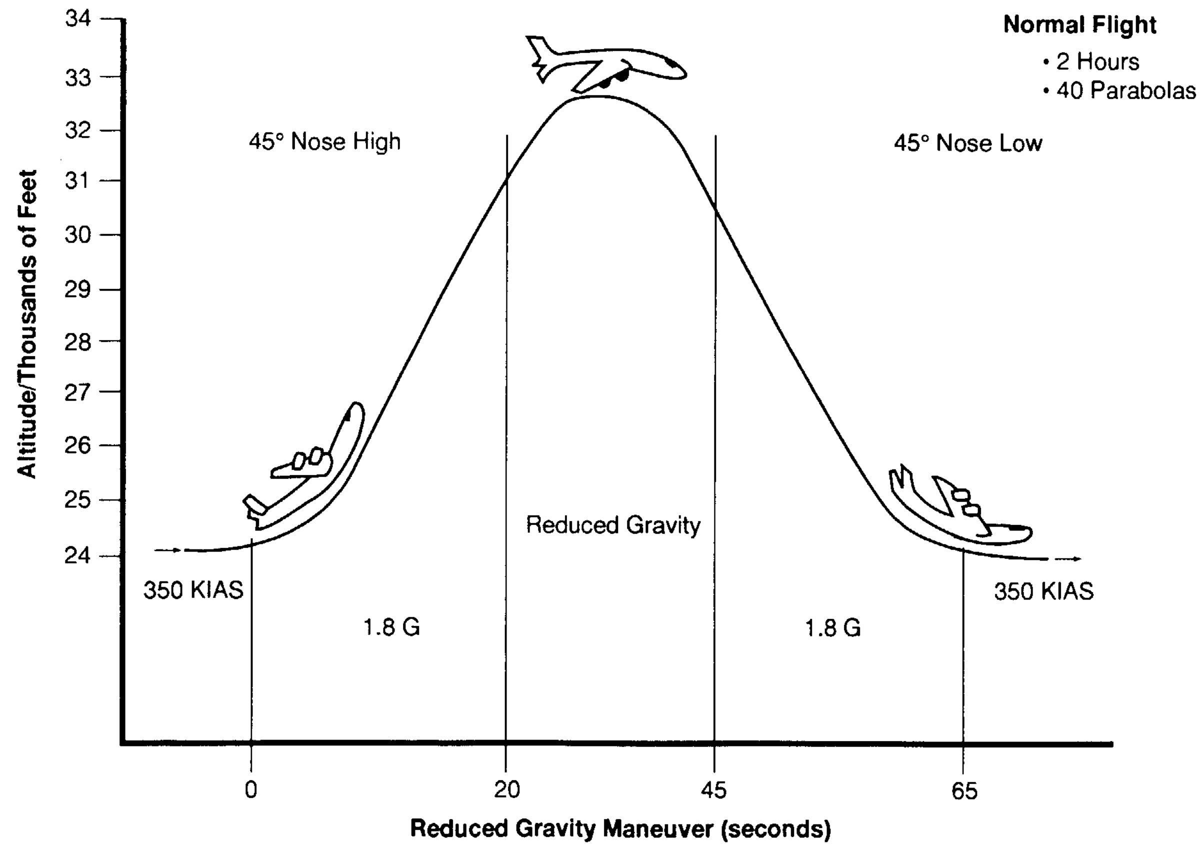

Figure 1. KC–135 aircraft trajectory.[15]

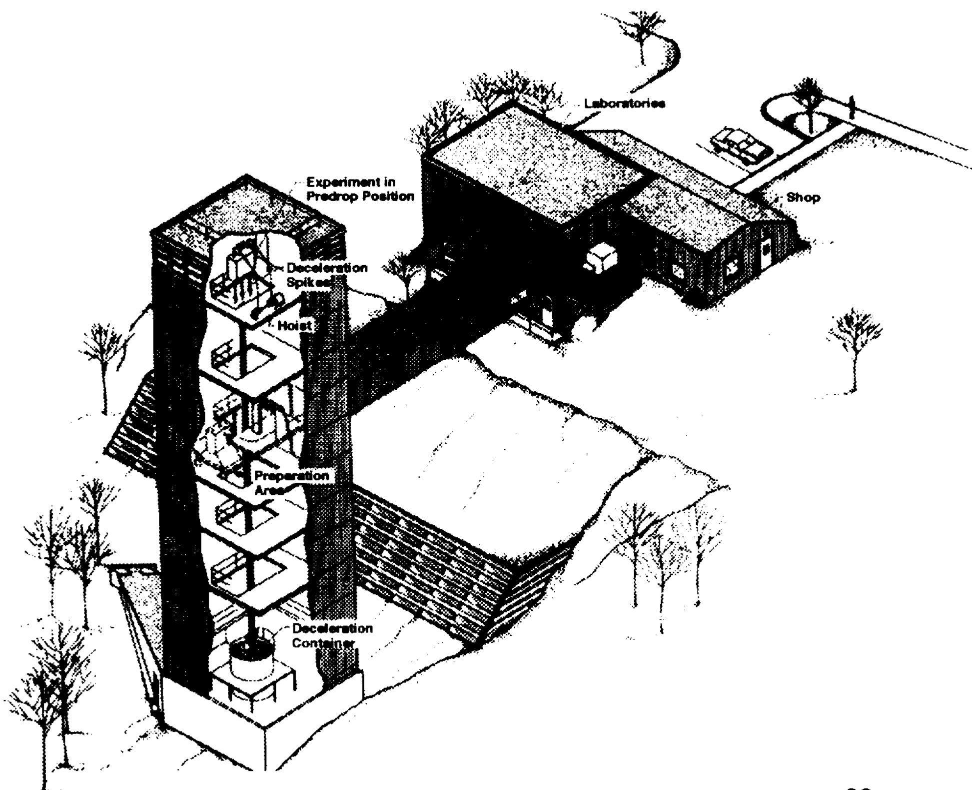

Figure 2. The 2.2–s drop tower at NASA LeRC.[20]

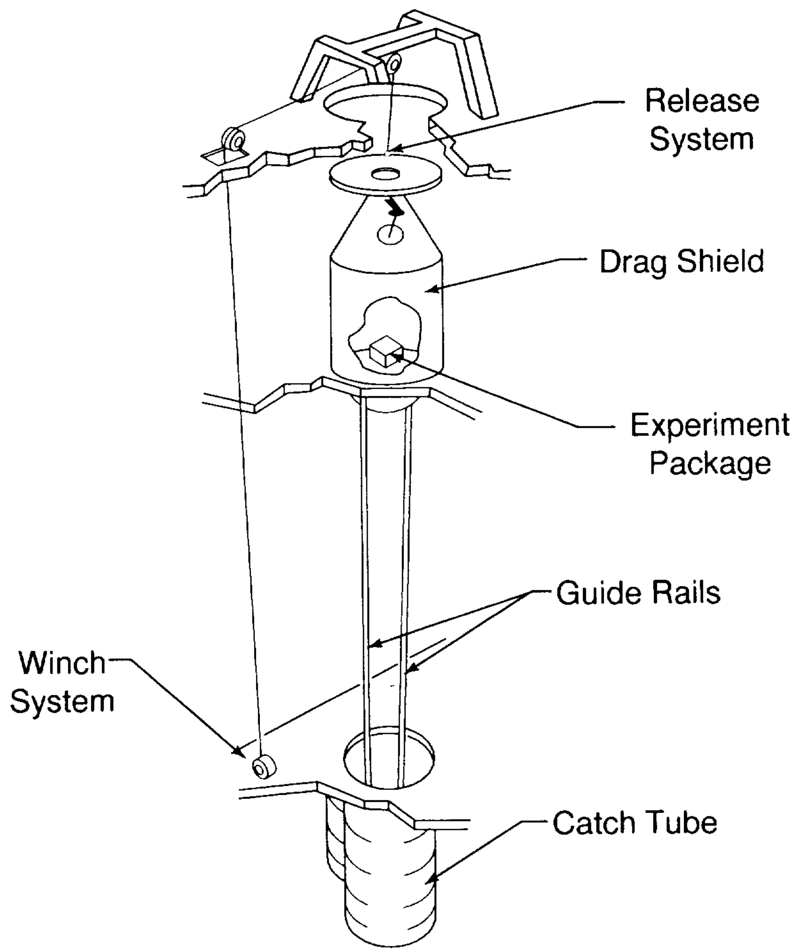

Figure 3. The 100–m drop tower at NASA MSFC.[14]

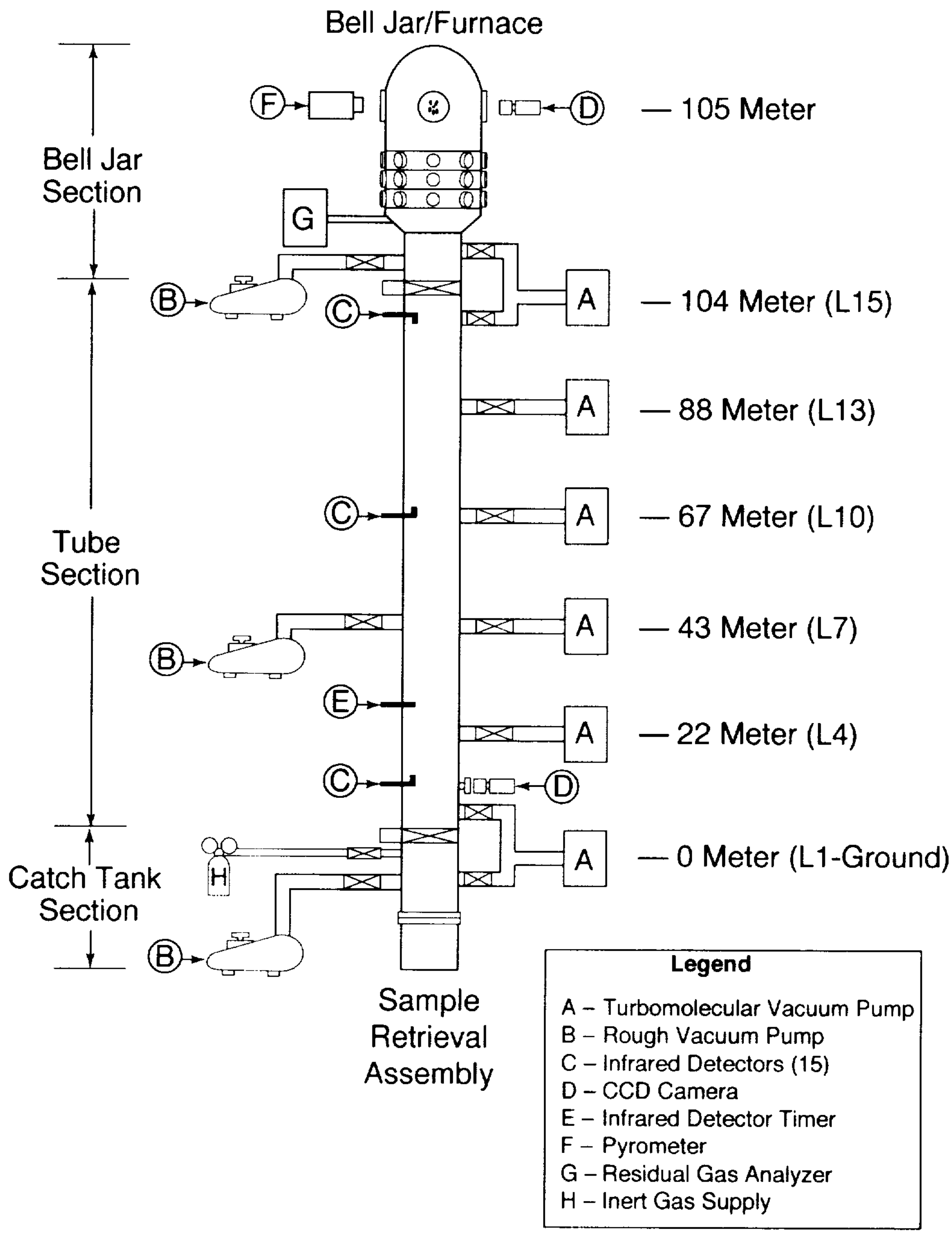

Figure 4. The 105–m drop tube at NASA MSFC.[30]

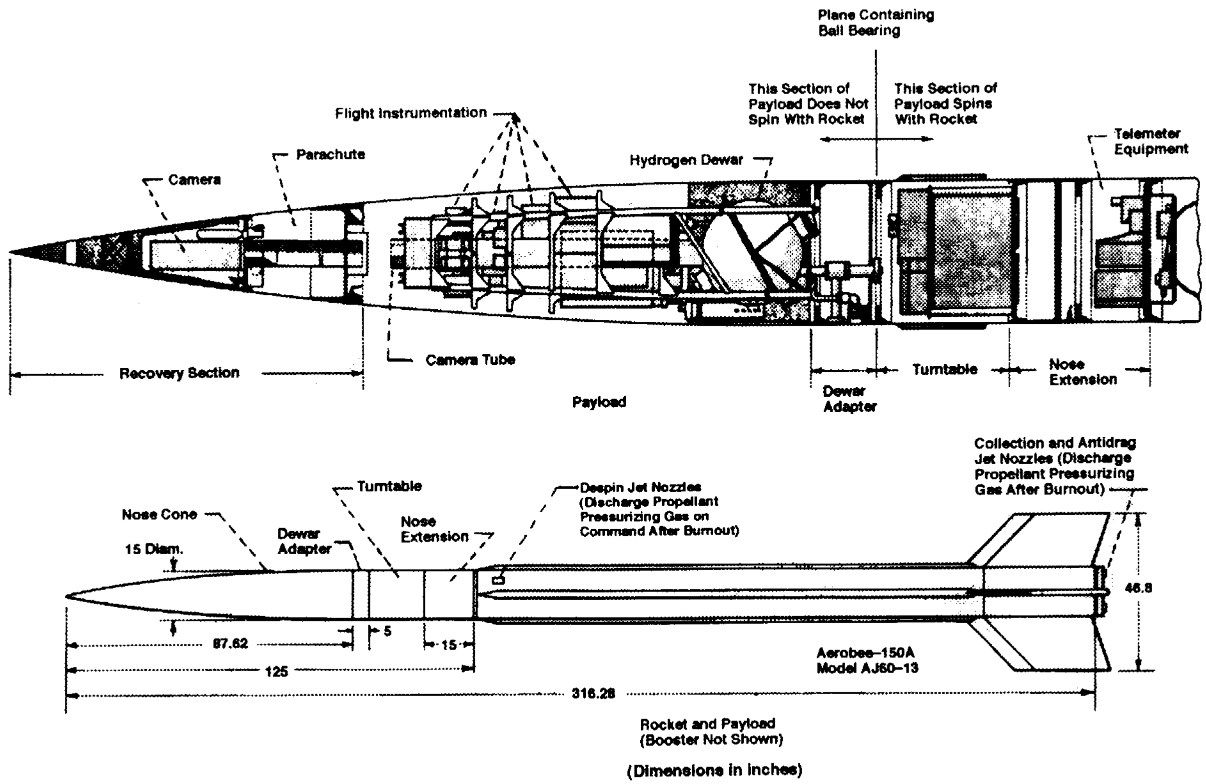

Figure 5. The major components of the Aerobee rocket (flight No. 2).[34]

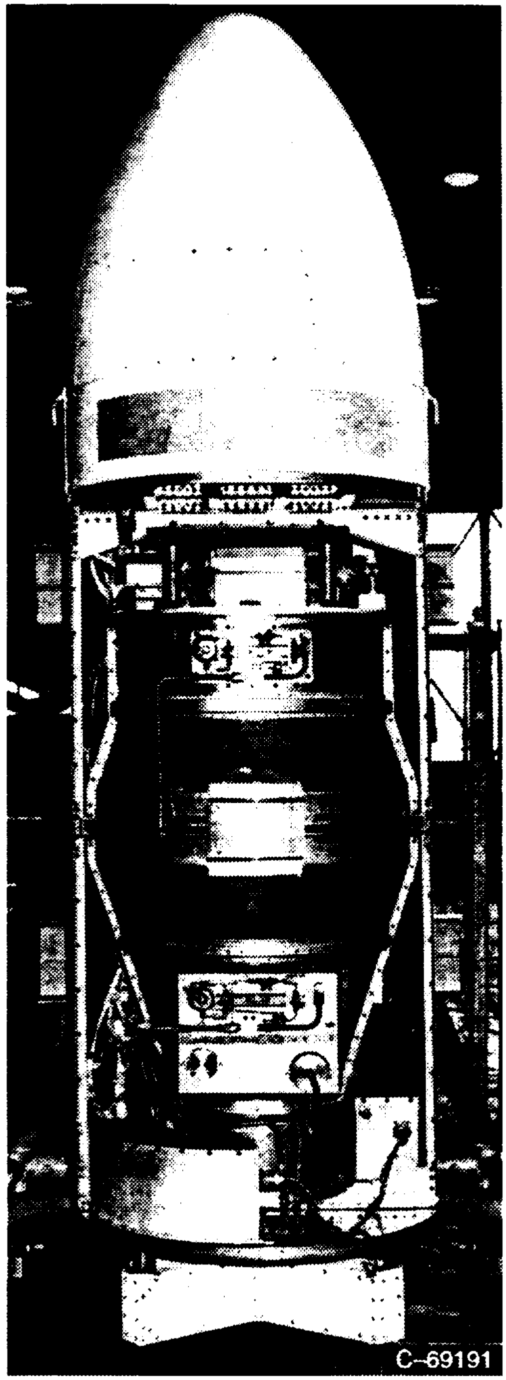

Figure 6. The Atlas flight experiment mounted in the passenger pod.[37]

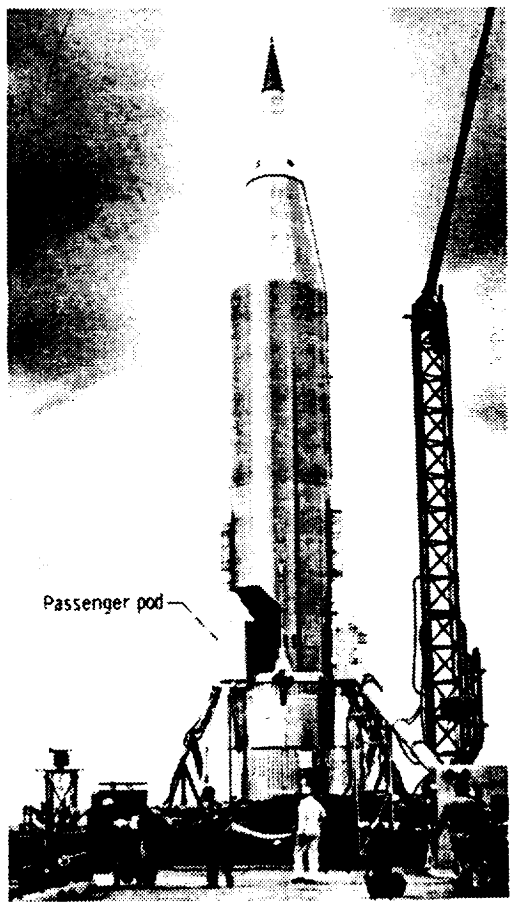

Figure 7. The experiment pod mounted on the Atlas missile.[37]

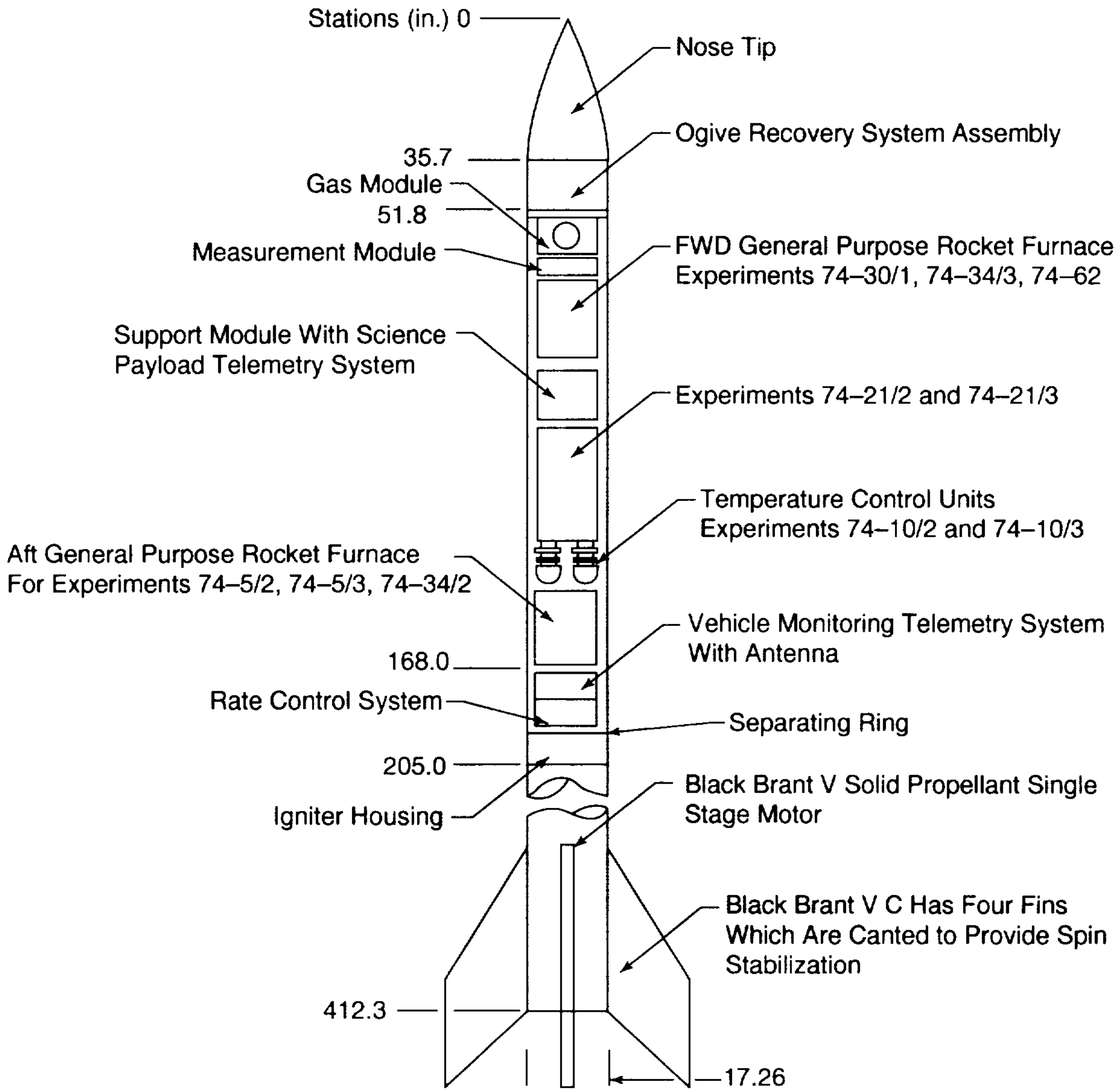

Figure 8. The SPAR 2 rocket configuration.[41]

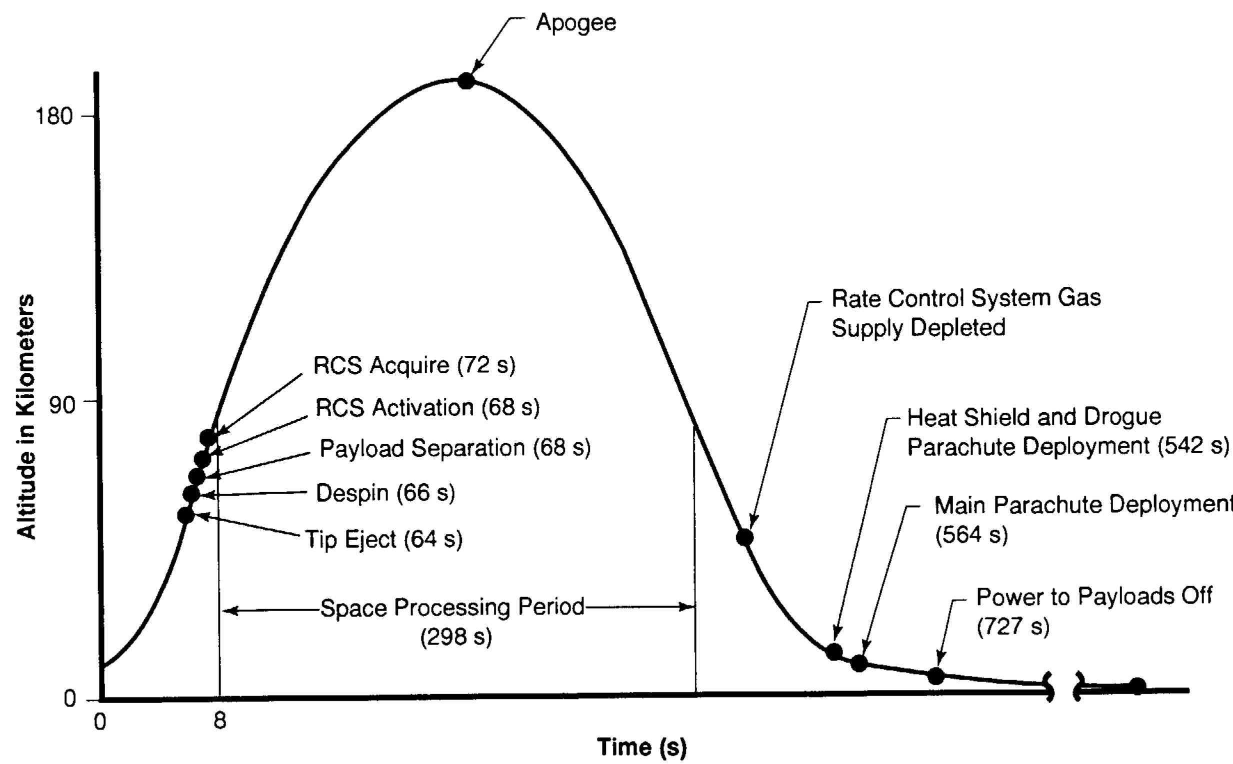

Figure 9. Flight profile of the SPAR 10.[39]

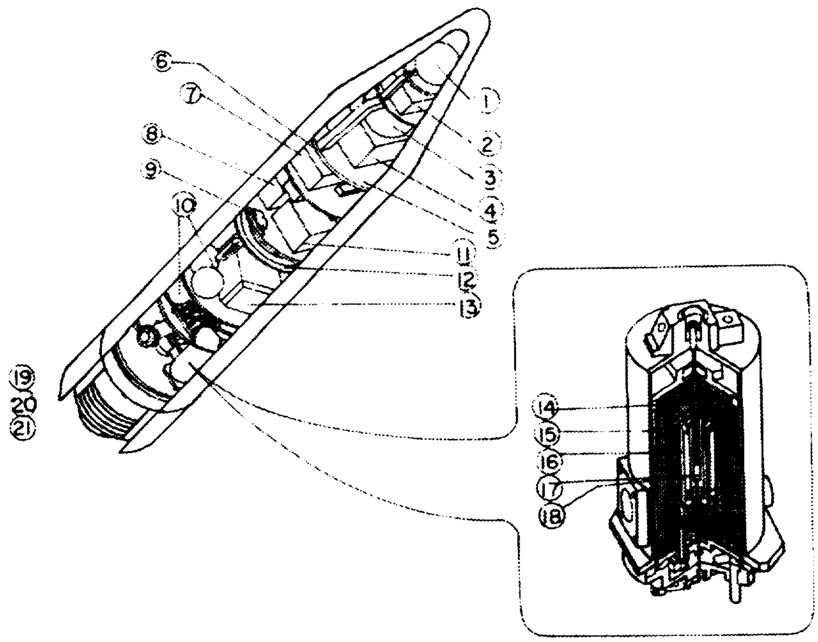

Figure 10.* Major components of the TT–500A rocket.[44]

(1) H_2 tank for gas jet system, (2) Power/sequence distribution box, (3) Control battery, (4) Control electronics, (5) Gas jet thruster, (6) Guidance transponder, (7) Inertial sensor package, (8) Tracking transponder, (9) Yo-yo despinner, (10) Cooling manipulation system, (11) Telemetry system, (12) Furnace battery, (13) Heater control device, (14) Pushing piston for test piece, (15) Bobbin type heater, (16) Melting pot, (17) Test piece, (18) Multi-layer reflector, (19) Location aid, (20) Main parachute, and (21) Drogue parachute.

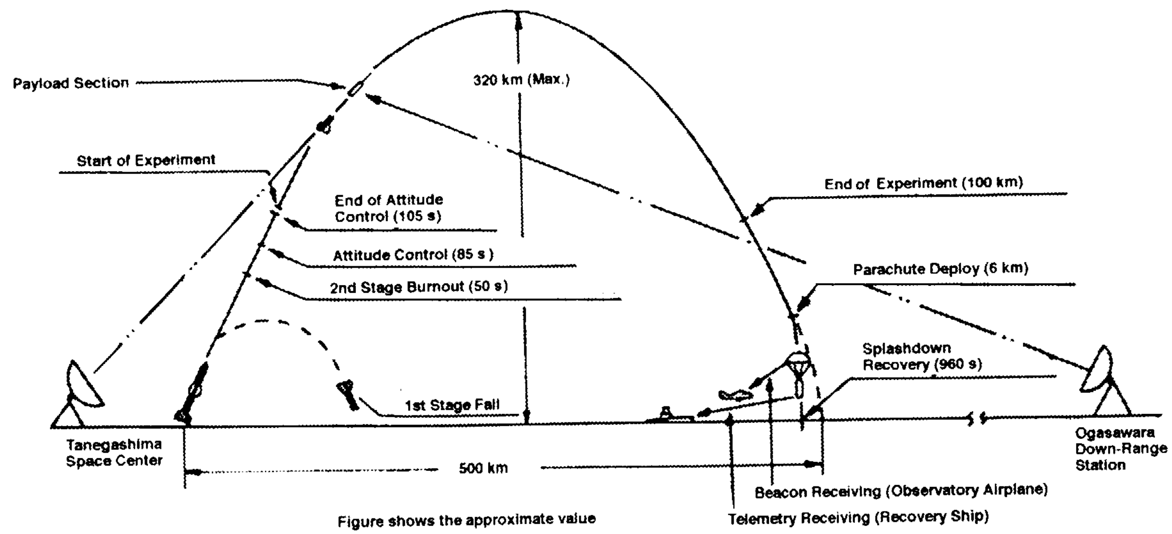

Figure 11.* Typical TT–500A rocket trajectory.[44]

* This figure was reproduced with permission from the American Ceramic Society. Anyone wishing to further reproduce it must contact the American Ceramic Society.

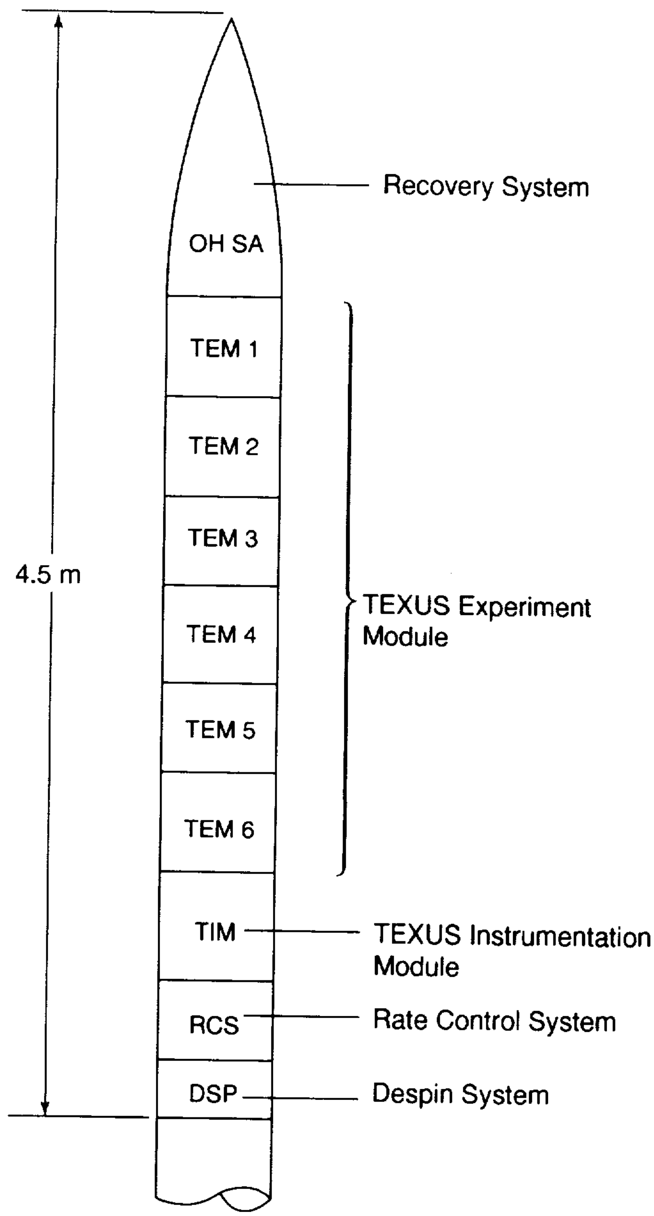

Figure 12. The payload section of the TEXUS vehicle.[52]

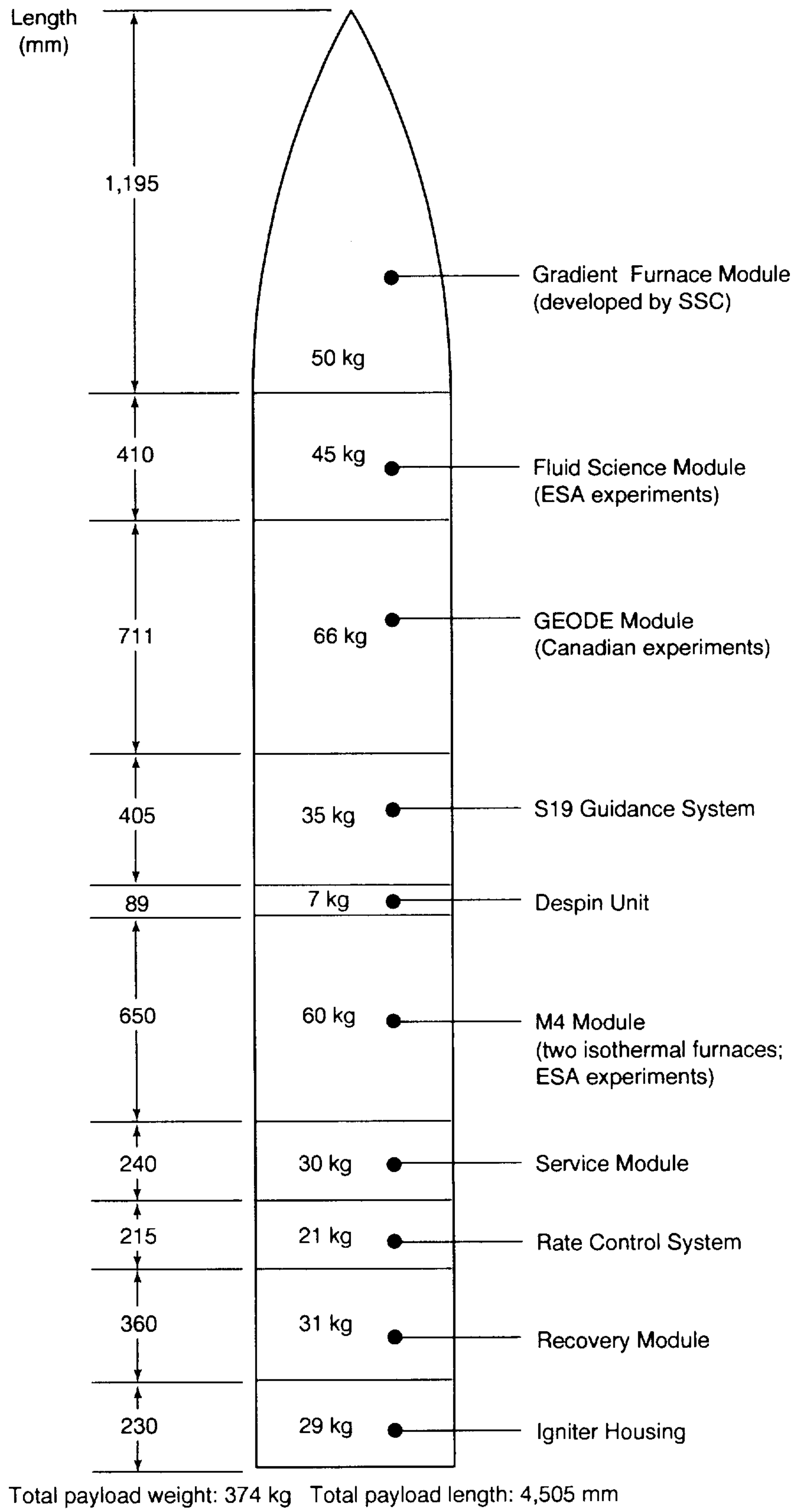

Figure 13. The MASER 1 payload configuration.[55]

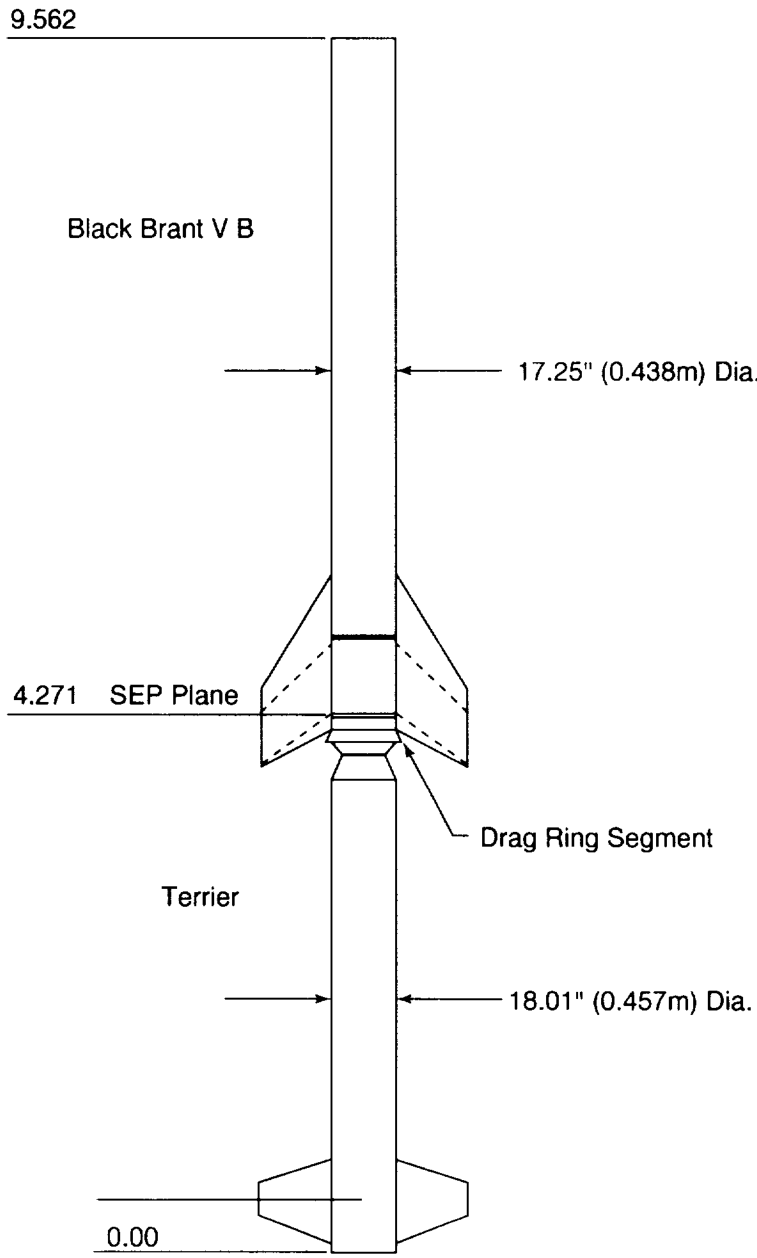

Figure 14. The MASER 1 rocket configuration.[54]

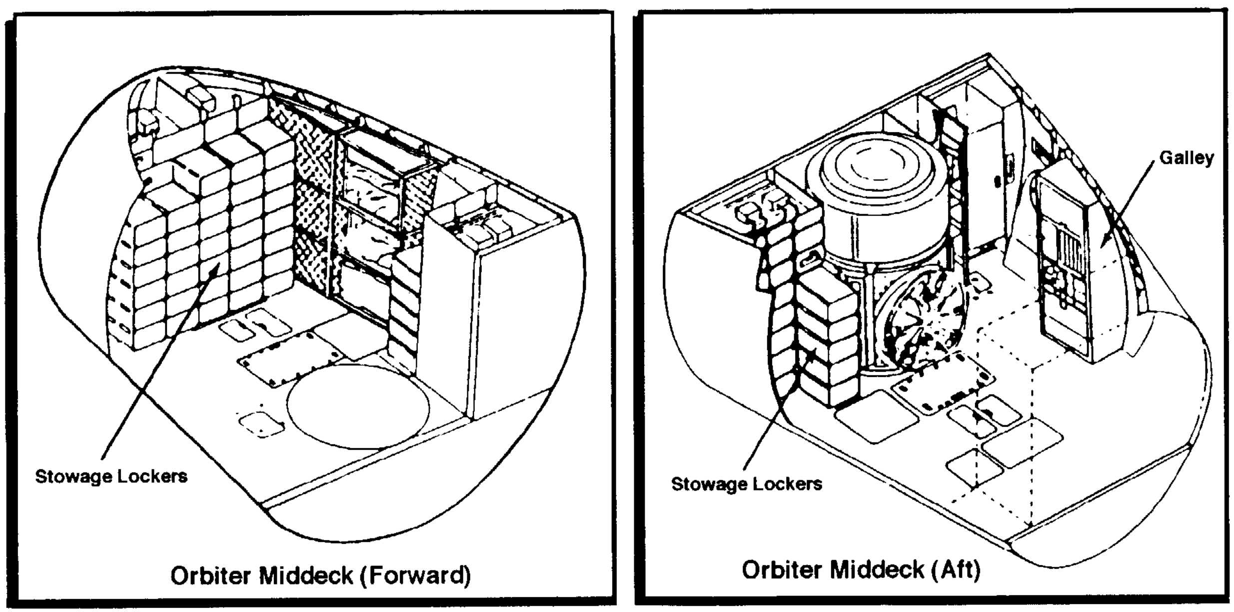

Figure 15. The foward and aft sections of the shuttle middeck.[20]

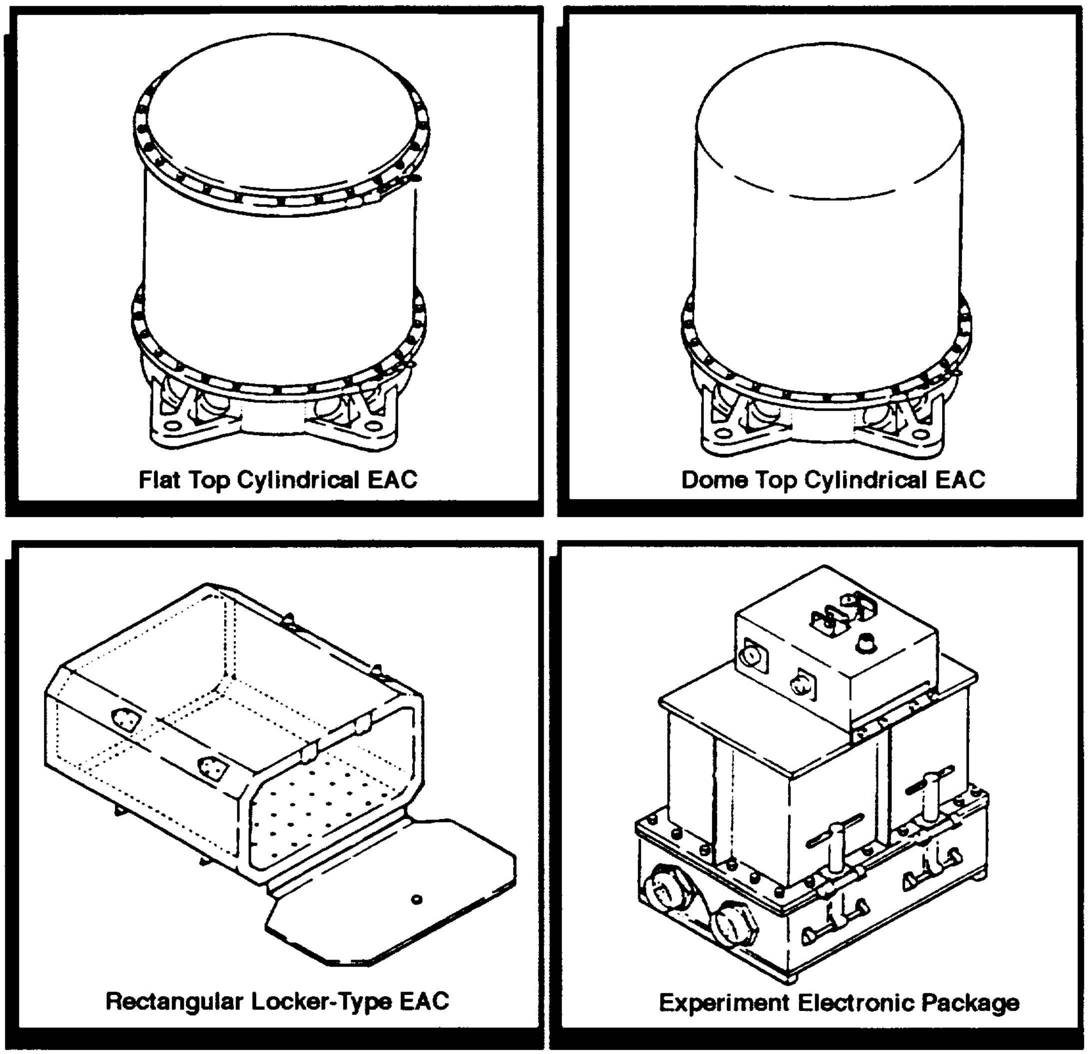

Figure 16. Experiment apparatus containers.[20]

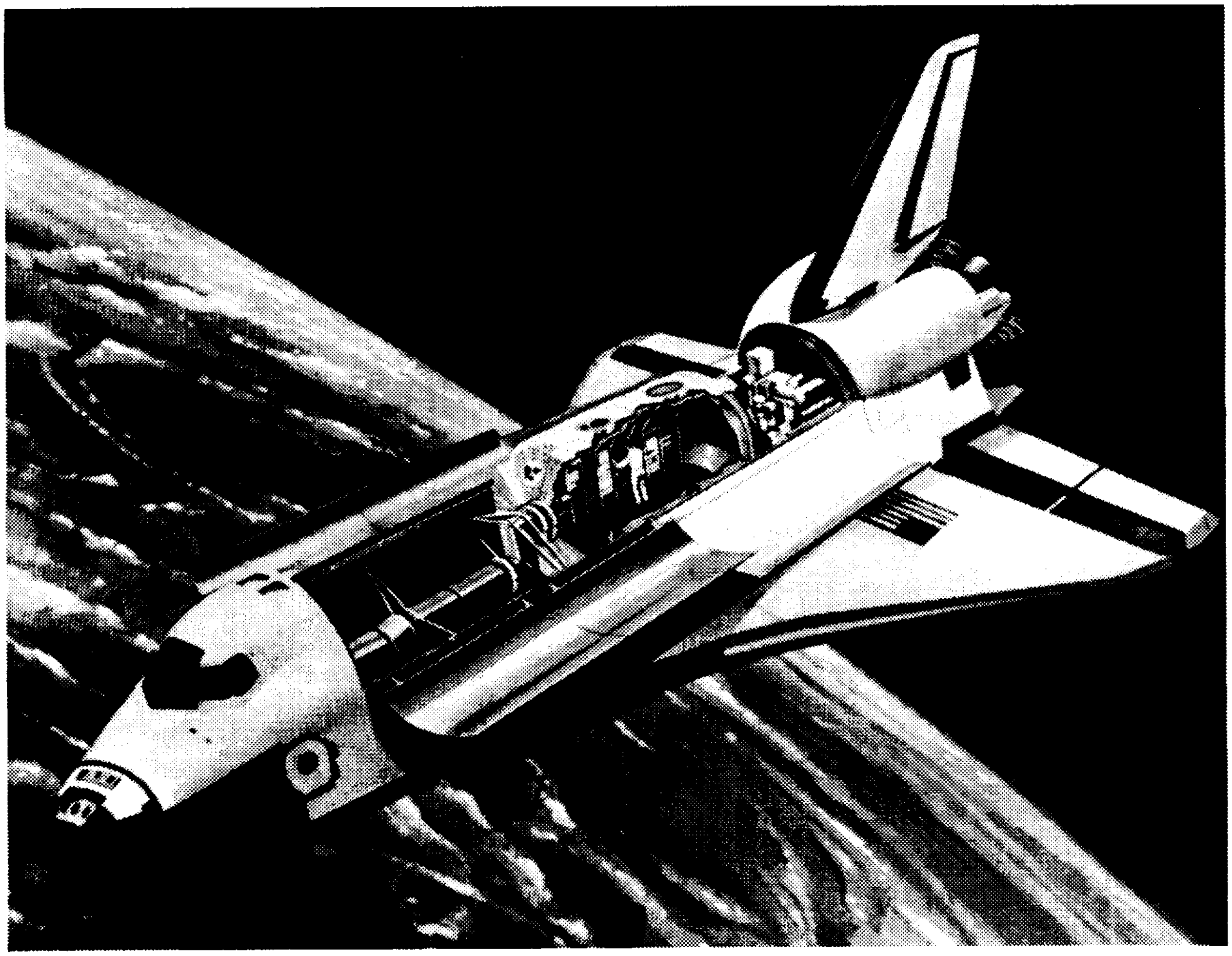

Figure 17. Spacelab module with access tunnel.[71]

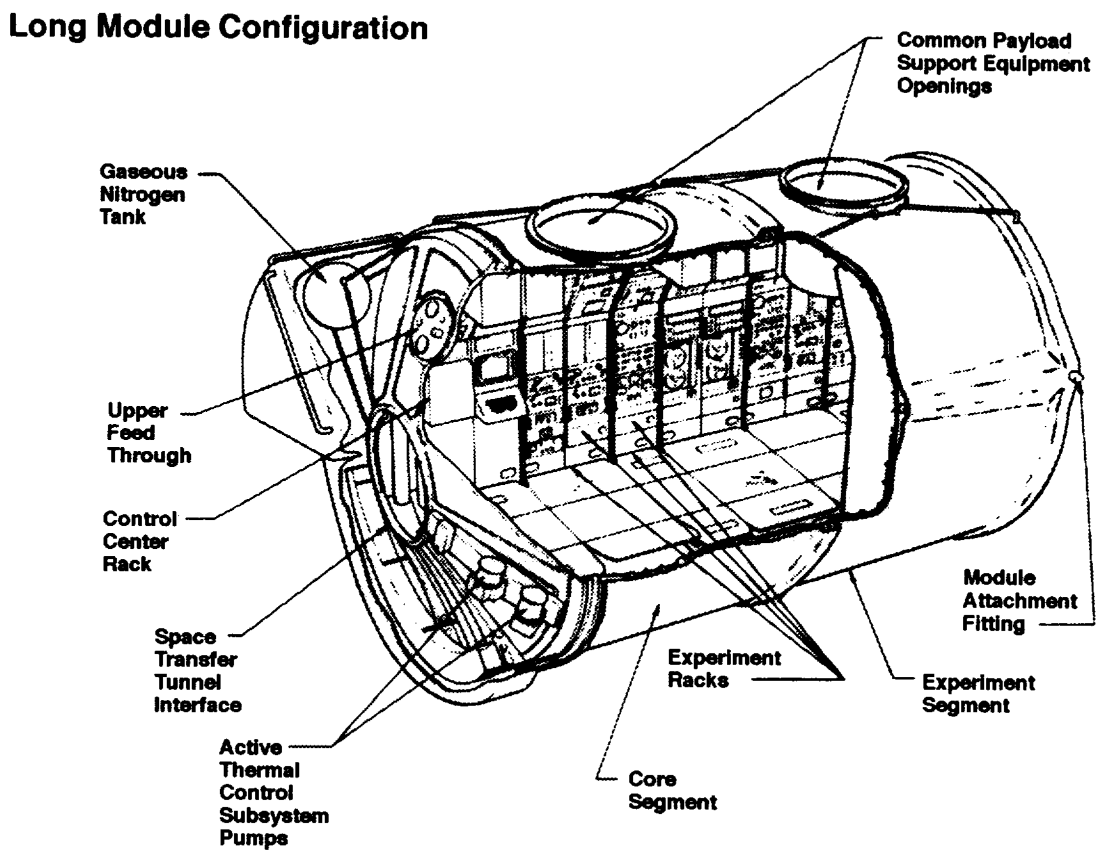

Figure 18. Spacelab long module.[71]

Get Away Special
Small Self-Contained Payloads

Container Concept

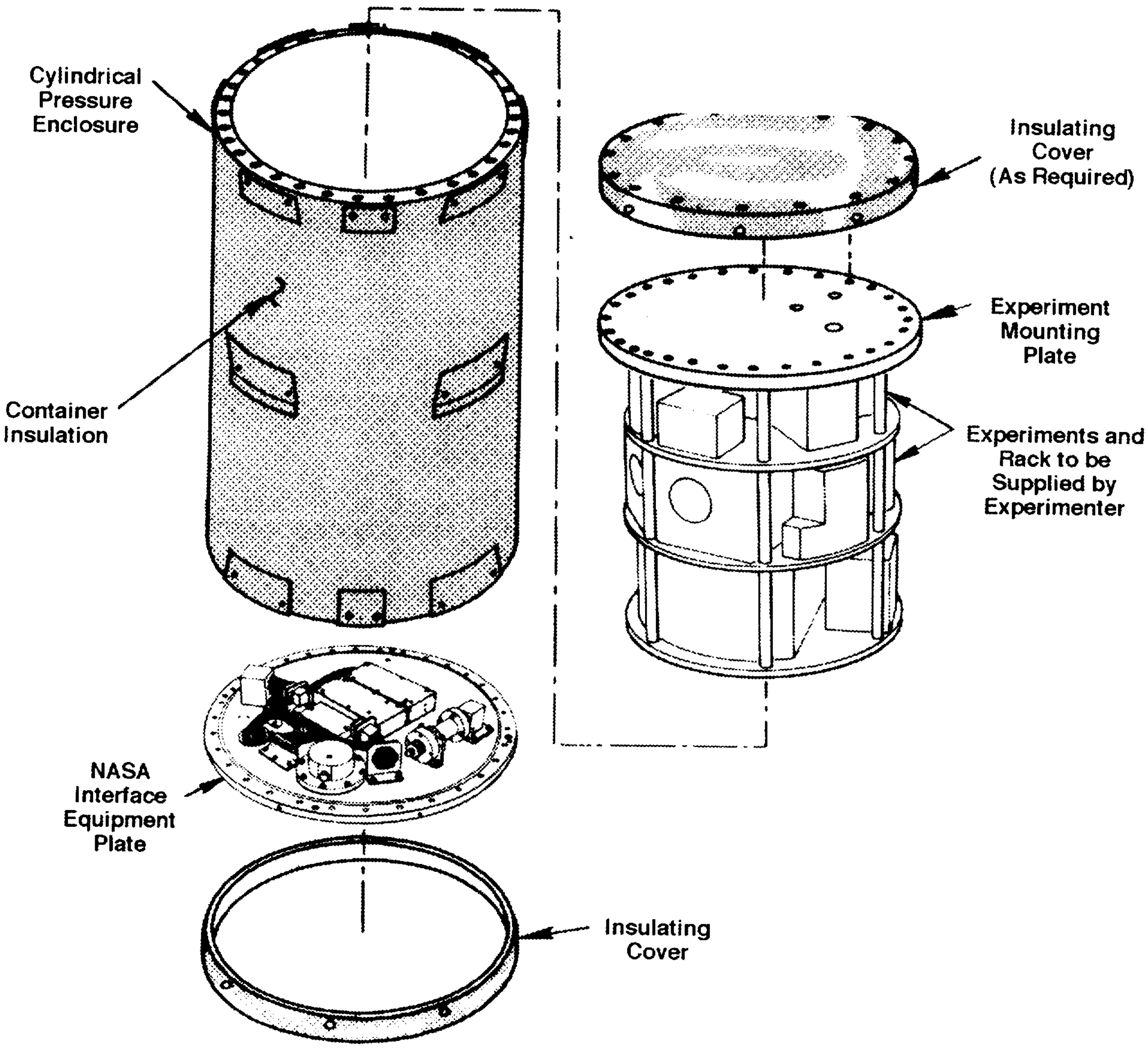

Figure 19. GAS Canister.[81]

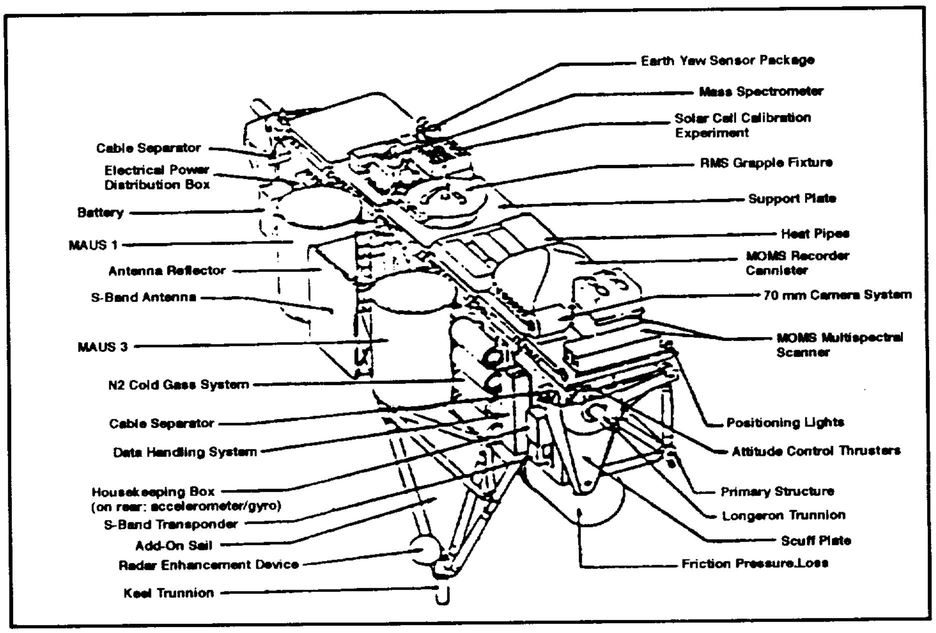

Figure 20.* The shuttle pallet satellite (SPAS).[84]

* This figure was reproduced with permission from Aviation Week and Space Technology. Anyone wishing to further reproduce it must contact Aviation Week and Space Technology.

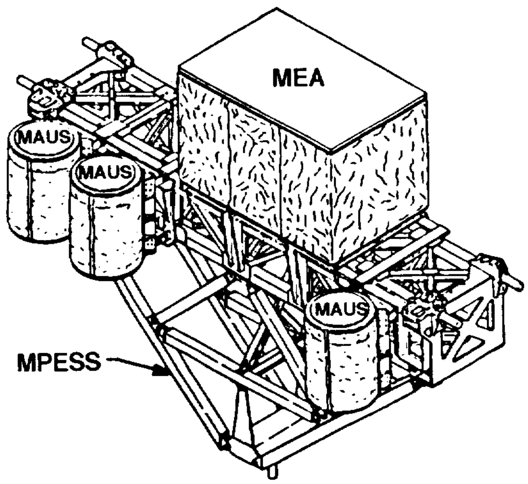

Figure 21. Elements of the OSTA–2 payload.[91]

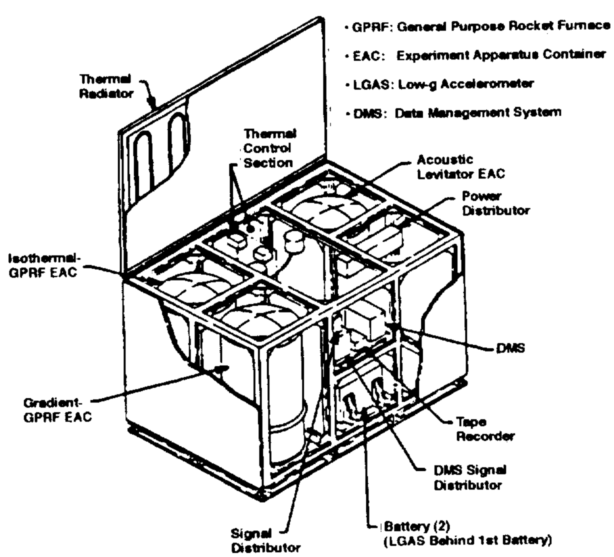

Figure 22. The materials experiment assembly (MEA).[91]

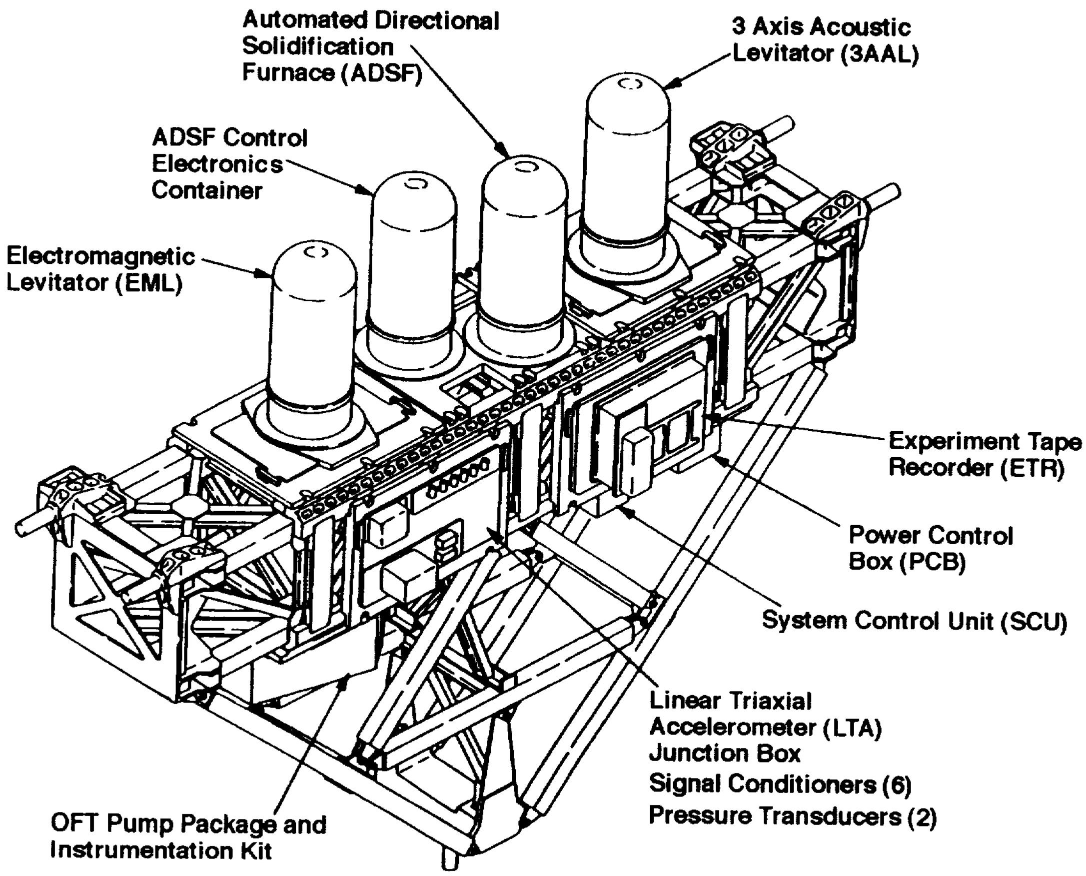

Figure 23. The materials science laboratory (MSL).[95]

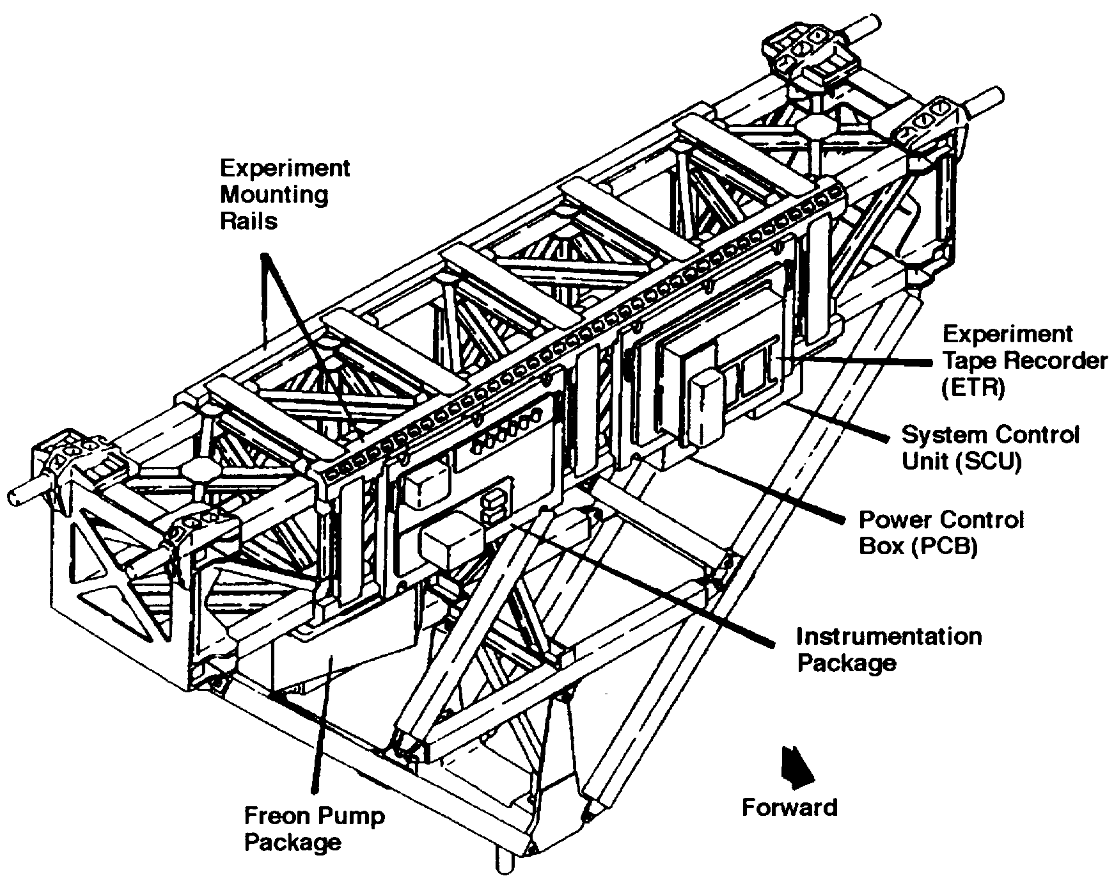

Figure 24. The U.S. microgravity payload (USMP) subsystems.[96]

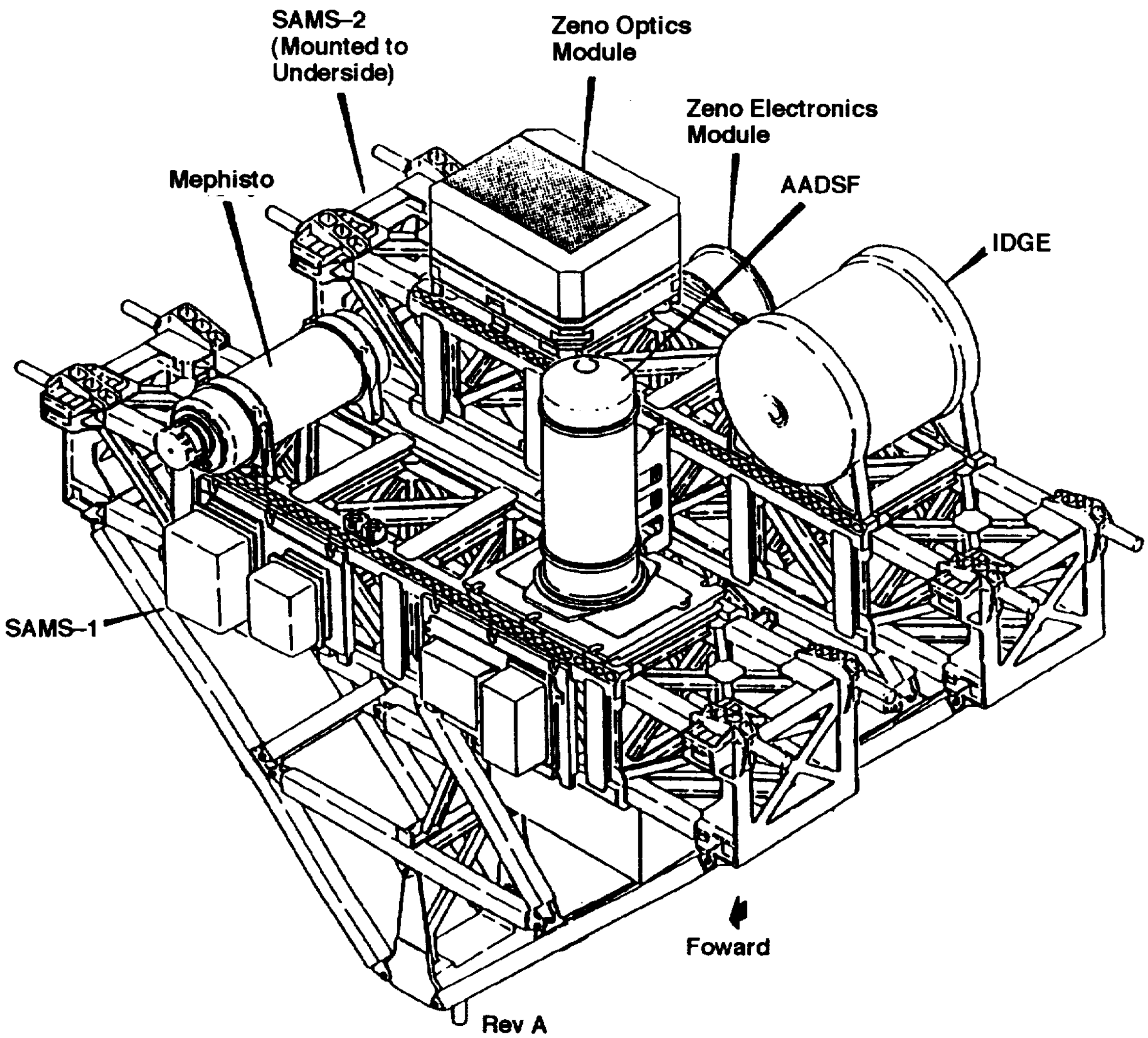

Figure 25. The USMP-2 experiments mounted on two MPESS's.[102]

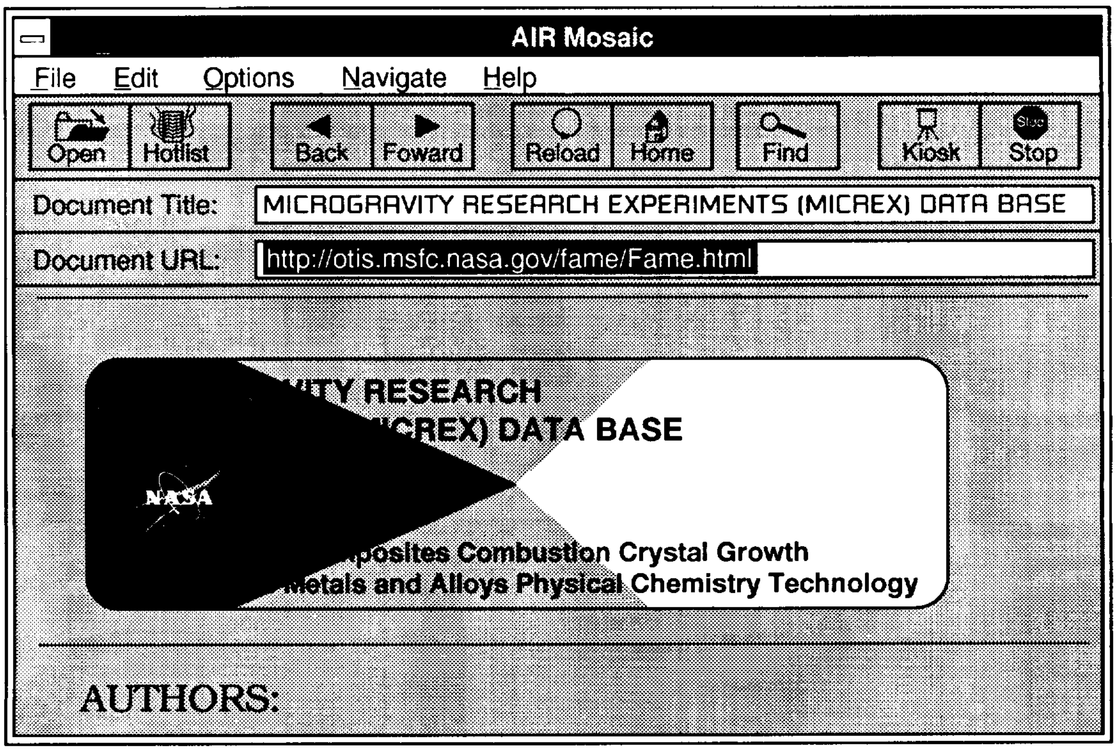

Figure 26. MICREX WWW access via Air Mosaic.

Section 2: Entire Experiments Listing

Chapter 1
Biotechnology

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

McKannan, E. C., et al.: Electrophoretic Separation (Apollo 14, 1971) 1-3

Snyder, R. S., et al.: Electrophoresis Demonstration (Apollo 16, 1972) 1-6
Snyder, R. S., et al.: Electrophoresis Experiment Verification Test (STS OFT-3, 1982) 1-10

McGee, K., et al.: The Effect of Zero Gravity on the Colloidal State of Matter (Skylab) 1-14

Bier, M., et al.: Role of Gravity in Preparative Electrophoresis; Charged Particle Mobility (Skylab SL-4, 1973,1974) 1-17
Bier, M., et al.: Isoelectric Focusing Experiment (STS 41-B, 1984) 1-22
Bier, M., et al.: Isoelectric Focusing Experiment (STS-26, 1988) 1-26

Allen, R. E., et al.: Electrophoresis Technology (ASTP, 1975) 1-29

Hannig, K.: Electrophoresis (ASTP, 1975) 1-35
Hannig, K.: Electrophoretic Separation (TEXUS 18, 1988) 1-41

Lanham, J. W., et al.: Continuous Flow Electrophoresis System (CFES) (STS OFT-4, 1982) 1-43
Lanham, J. W., et al.: CFES (STS 31-B, 1983) 1-48
Lanham, J. W., et al.: CFES (STS 31-C, 1983) 1-53
Lanham, J. W., et al.: CFES (STS 41-D, 1984) 1-57
Lanham, J. W., et al.: CFES (STS 51-D, 1985) 1-61
Lanham, J. W., et al.: CFES (STS 61-B, 1985) 1-65

Hymer, W. C., et al.: Continuous Flow Electrophoresis System (CFES):Pituitary Cell Separation (STS 31-D, 1983) 1-69

Chapter 1, Cont.
Biotechnology

Listed Primarily Chronologically, but with Investigative Series of Principal Investigators Intact

Page

Morrison, D. R., et al.: Continuous Flow Electrophoresis System (CFES): Kidney Cell Separation (STS 31-D, 1983) 1-73

Morrison, D. R., et al.: Attachment of Human Embryonic Kidney Cells to Microcarrier Beads in Microgravity (STS 31-D, 1983) 1-78

Scharp, D., et al.: Continuous Flow Electrophoresis System (CFES): Pancreas Cell Separation (STS 31-D, 1983) 1-83

Cogoli, A., et al.: Lymphocyte Proliferation in Weightlessness (STS Spacelab 1, 1983) 1-86

Cogoli, A., et al.: Lymphocyte Activation (STS Spacelab D1, 1985) 1-90

Brooks, D. E., et al.: Phase Partitioning Experiment (STS 51-D, 1985) 1-95

Brooks, D. E., et al.: Phase Partitioning Expt. (STS-26, 1988) 1-101

Zimmermann, U., et al.: Electrofusion of Yeast Protoplasts (EYP) (TEXUS 11, 1985) 1-105

Zimmermann, U., et al.: EYP (TEXUS 13, 1986) 1-108

Zimmermann, U., et al.: EYP (TEXUS 14a, 1986) 1-111

Zimmermann, U., et al.: EYP (TEXUS 14b, 1987) 1-113

Zimmermann, U., et al.: EYP (TEXUS 18, 1988) 1-118

Surgenor, D. M., et al.: Initial Blood Storage System (STS 61-C, 1986) 1-121

Hampp, R.: Electrofusion of Cell Protoplasts (TEXUS 17, 1988) 1-125

Hammerstedt, R., et al.: Microtuble Assembly (Consort 1, 1989) 1-128

Luttges, M. W., et al.: Collagen Polymerization (Consort 1, 1989) 1-135

Chapter 1, Cont.
Biotechnology
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Pellegrino, J.: Chitosan Membrane Formation (Consort 1, 1989) 1-140
Pellegrino, J., et al.: Ceramic Membrane Casting (Consort 1, 1989) 1-144
Pellegrino, J.: Nafion Membrane Formation (Consort 1, 1989) 1-148

Stodieck, L. S., et al.: Fibrin Clot Formation (Consort 1, 1989) 1-152

Todd, P.: Electrophoretic Transfer (Consort 1, 1989) 1-157
Todd, P.: Phase Rearrangement (Consort 1, 1989) 1-161

Vera, I.: Cellulose Acetate Membrane Formation (Consort 1, 1989) 1-165
Vera, I.: Polysulfone Membrane Formation (Consort 1, 1989) 1-170

<Note: Experiments related to Protein Crystal Growth can be found in Chapter 16.>

<Note: An experiment entitled Aggregation of Red Blood Cells (STS 51-C, 1985) by **Principal Investigator L. Dintenfass** (Kanematsu Institute, Department of Medical Research, Sydney, Australia) should have been included in this Chapter. Information on the experiment was discovered after this Technical Memorandum had been prepared. Details of this experiment should appear in later versions of the MICREX.>

Chapter 2
Capillarity

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Johnston, R. G., et al.: Capillary Study (Skylab SL-4, 1973,1974) 2-3

Grodzka, P. G., et al.: The Formaldehyde Clock Reaction/Chemical Foaming (ASTP, 1975) 2-6

Grodzka, P. G., et al.: Equilibrium Shift Reaction/ Chemical Foaming (ASTP, 1975) 2-9

Whitaker, A.: Capillary Wicking (ASTP, 1975) 2-13

Sell, P. J., et al.: Wetting Kinetics/Capillarity (TEXUS 2, 1978) 2-16

Sell, P. J., et al.: Wetting Kinetics (TEXUS 3, 1980) 2-19

Sell, P. J., et al.: Wetting Kinetics/Capillarity (TEXUS 3b, 1981) 2-21

Sell, P. J., et al.: Wetting Kinetics/Capillarity (TEXUS 5, 1982) 2-24

Sell, P. J.: Bubbles and Foams (TEXUS 10, 1984) 2-26

Da Riva, I., et al.: Floating Zone Stability in Zero Gravity (STS Spacelab 1, 1983) 2-28

Da Riva, I., et al.: Floating Liquid Zone (FLIZ) Hydrodynamics (STS Spacelab D1, 1985) 2-33

Padday, J. F.: Capillary Forces (STS Spacelab 1, 1983) 2-37

Padday, J. F.: Capillary Experiments (STS Spacelab D1, 1985) 2-41

Kitaura, T., et al.: Capillary Wave Study (STS 41-B, 1984) 2-46

Kitaura, T., et al.: Capillary Wave Study (STS 41-G, 1984) 2-49

Martínez, I., et al.: Maximum Injection Rate in a Floating Zone (TEXUS 10, 1984) 2-52

Martínez, I., et al.: Maximum Injection Rate in a Floating Zone (TEXUS 12, 1985) 2-54

Martínez, I., et al.: Freezing of a Long Liquid Column (TEXUS 18, 1988) 2-58

Chapter 2, Cont.

Capillarity

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Foster, K., et al.: Wicking of Freon
(STS 51-G, 1985)...................................... 2-62

Todd, P.: Capillary Flow Studies (Consort 1, 1989).... 2-65

Chapter 3
Combustion Studies
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Kimzey, J. H.: Zero Gravity Flammability
(Skylab SL-4, 1974) 3-3

Chapter 4
Composites with Gases

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Deruyttere, A., et al.: Silver Grids Melted in Space (Skylab SL-3, 1973) 4-3

Patten, J. W., et al.: Feasibility of Producing Closed Cell Metal Foams from Sputter-Deposited Inert Gas Bearing Metals and Alloys (SPAR 1, 1975) 4-9

Patten, J. W., et al.: Feasibility of Producing Closed Cell Metal Foams from Sputter-Deposited Inert Gas Bearing Metals and Alloys (SPAR 2, 1976) 4-13

Hoffmeister, H.: Pores in Al-Alloys (TEXUS 3, 1980) 4-16

Hoffmeister, H., et al.: Pores in Al-Alloys (TEXUS 3b, April 1981) 4-19

Pond, R. B., et al.: Foam Copper (SPAR 9, 1981) 4-22

Pond, R. B., et al.: Foam Copper (SPAR 10, 1983) 4-24

Pötschke, J., et al: Metallic Steel Foams -Part 1 of 2- (TEXUS 4, 1981) 4-27

Pötschke, J., et al: Metallic Steel Foams -Part 2 of 2- (TEXUS 4, 1981) 4-29

Pötschke, J., et al: Metallic Steel Foams (TEXUS 6, 1982) 4-32

Pötschke, J., et al: Manufacture of Iron Foam (TEXUS 7, 1983) 4-35

Schäfer, W.: Metallic Foams (TEXUS 5, 1982) 4-38

Schäfer, W.: Preparation of Aluminum Foams (TEXUS 9, 1984) 4-41

Neel, R. R., et al.: Formation of Foam Metal (STS 31-B, 1983) 4-44

Gondi, P.: Bubble Reinforced Materials (Spacelab 1, 1983) 4-47

Potard, C., et al.: Solidification of Al-Zn Vapor Emulsion (Spacelab 1, 1983) 4-51

Chapter 4, Cont.

Composites with Gases

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Safman, R., et al.: Honeycombed Structures-Creation of Metallic Foam (STS 61-C, 1986)............ 4-55

McManus, S. P., et al.: Foam Formation (Consort 1, 1989).................................... 4-57

<Note: Three additional foaming experiments can be found in Chapter 2: Capillarity.>

Chapter 5
Composites With Solid Particles

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Fabiniak, R. C., et al.: Composite Casting-Part I: Powder Metallurgy Samples (Apollo 14, 1971) 5-3

Peters, E., et al.: Composite Casting-Part II: Eutectic Solidification Samples (Apollo 14, 1971) 5-7

Steurer, W. H., et al.: Composite Casting-Part IV: Fiber Reinforced Matrix Samples (Apollo 14, 1971) 5-10

<Note: Deruyttere, A. had a somewhat related experiment on Skylab. See Deruyttere, A., et al.: Silver Grids Melted in Space (Skylab SL-3, 1973), p. 4-3.>

Deruyttere, A., et al.: Metallic Particle Composites (TEXUS 6, 1982) 5-14

Deruyttere, A., et al.: Metallic Particle Composites (TEXUS 7, 1983) 5-18

Deruyttere, A., et al.: Melting and Solidification of Metallic Composites (STS Spacelab 1, 1983) 5-22

Deruyttere, A., et al.: Metallic Particle Composites (TEXUS 9, 1984) 5-26

Deruyttere, A., et al.: Metallic Particle Composites (STS Spacelab D1, 1985) 5-29

Deruyttere, A., et al.: Metallic Particle Composites (TEXUS 14a, 1986) 5-33

Deruyttere, A., et al.: Metal Matrix Composites (TEXUS 14b, 1987) 5-35

Deruyttere, A., et al.: Metal Matrix Composites (TEXUS 16, 1987) 5-39

Kawada, T., et al.: Whisker Reinforced Composites (Skylab SL-3, 1973) 5-41

Kawada, T., et al.: Whisker Reinforced Composites (Skylab SL-4, 1973) 5-45

Raymond, L., et al.: Casting Dispersion-Strengthened Composites (SPAR 1, 1975) 5-48

Raymond, L., et al.: Casting Dispersion-Strengthened Composites (SPAR 2, 1976) 5-52

Chapter 5, Cont.
Composites With Solid Particles
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Uhlmann, D. R., et al.: Uniform Dispersions of Crystallization Processing (SPAR 1, 1975)............ 5-57
Uhlmann, D. R., et al.: Uniform Dispersions of Crystallization Processing (SPAR 4, 1977).......... 5-62
Uhlmann, D. R.: Uniform Dispersions by Crystallization (SPAR 5, 1978)...................... 5-66

Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (TEXUS 1, 1977)............................ 5-69
Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (TEXUS 2, 1978).......................... 5-72
Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (TEXUS 3, 1980).......................... 5-76
Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (TEXUS 3b, 1981).......................... 5-79
Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (TEXUS 5, 1982) 5-82
Neuschütz, D., et al.: Metal Alloy with Oxide Inclusions (STS Spacelab 1, 1983).................. 5-85
Neuschütz, D., et al.: Metal-Metal Suspension (TEXUS 9, 1984).................................... 5-87

Walter, H. U., et al.: Stability of Compound Mixtures/Powder Metallurgy (TEXUS 1, 1977)............ 5-90
Walter, H. U., et al.: Stability of Compound Mixtures/Powder Metallurgy (TEXUS 2, 1978).......... 5-95

Takahashi, S.: Ni-TiC Composite Alloy (TT-500A 8, 1980)....................................... 5-99
Takahashi, S.: Ni-TiC Composite Alloy (TT-500A 9, 1981)................................... 5-104
Takahashi, S.: Ni-TiC Composite Alloy (TT-500A 11, 1982).................................. 5-106

Dalley, A. M., et al.: Composite Curing (STS OFT-4, 1982).................................... 5-109

Suzuki, T., et al: Fabrication of C-Fiber/Al Composite (TT-500A 13, 1983)......................... 5-113
Suzuki, T., et al.: $PbO-B_2O_3$3 Diamond Composite (TT-500A 13, 1983)................................. 5-116

Composites With Solid Particles

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

	Page
Caton, P. D., et al.: Manufacture of a Particle Dispersion (TEXUS 10, 1984)	5-118
Pötschke, J., et al.: Metal Oxide Copper-Alumina Suspension (TEXUS 11, 1985)	5-121
Pötschke, J., et al.: WC-Co Liquid Metal Suspension (TEXUS 12, 1985)	5-124
Pötschke, J., et al.: The Behavor of Aluminum Oxide Particles at the Solidification Front of Copper (STS Spacelab D1, 1985)	5-126
Goodhew, P. J., et al.: Retention of a Fine Precipitate Dispersion (TEXUS 12, 1985)	5-130
Goodhew, P. J., et al.: Retention of a Fine Precipitate Dispersion (TEXUS 14a, 1986)	5-132
Goodhew, P. J., et al.: Retention of a Fine Precipitate Dispersion (TEXUS 14b, 1987)	5-135
Langbein, D., et al.: Particles at Melting and Solidification Fronts (STS Spacelab D1, 1985)	5-140

Chapter 6
Containerless Processing

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

<Note: Semicontainerless float zone experiments can be found in Chapter 9: Crystal Growth From the Melt. Other experiments related to Containerless Processing Applications (such as the creation and acoustic positioning of liquid bubbles and the creation and stability of liquid zones) can be found in Chapter 12: Fluid Physics and Chapter 2: Capillarity.>

Page

Hasemeyer, E. A., et al.: Sphere Forming (Skylab SL-2, 1973) 6-3

Walter, H. U.: Growth of Spherical Crystals (Skylab SL-3, 1973) 6-8
  Walter, H. U.: Containerless Processing of Single Crystals (Skylab SL-4, 1973) 6-13

Wouch, G., et al.: Containerless Processing of Beryllium (SPAR 3, 1976) 6-17

Lord, A. E., Jr., et al.: Containerless Production of Bulk Metallic Glasses (SPAR 4, 1977) 6-21

Ahlborn, H.: Primary Crystallization of a Hypereutectic Antimony-Silver Alloy (TEXUS 1, 1977) ... 6-25

Happe, R. A.: Containerless Processing of Glass (SPAR 6, 1979) 6-28
  Happe, R. A., et al.: Glass Formation Experiment (SPAR 8, 1980) 6-32

Day, D. E.: Containerless Processing of Glass Forming Melts (STS 31-C, 1983) 6-35
  Day, D. E., et al.: Containerless Processing of Glass Forming Melts (STS Spacelab D1, 1985) 6-39

Doremus, R., et al.: Acoustic Containerless Experiment System (STS 41-B, 1984) 6-44

Chapter 6, Cont.
Containerless Processing
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Herlach, D. M.: Containerless Solid Solidification of a PdCuSi Sample (TEXUS 9, 1984)................... 6-48
Herlach, D. M.: Containerless Solid Solidification of a PdCuSi Sample (TEXUS 14a, 1986)................ 6-52
Herlach, D. M.: Containerless Solid Solidification of a PdCuSi Sample (TEXUS 14b, 1987)................ 6-54

Flemings, M. C.: Alloy Undercooling/Electromagnetic Levitator (STS 61-C, 1986)........................... 6-57

Chapter 7
Critical Point Phenomena
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Straub, J., et al.: Phase Separation/ Transformation (TEXUS 6, 1982) 7-3
Straub, J., et al.: Phase Separation/ Transformation-Part 1 (TEXUS 8, 1983) 7-5
Straub, J., et al.: Phase Separation/ Transformation-Part 2 (TEXUS 8, 1983) 7-8
Straub, J., et al.: Heat Capacity Near the Critical Point (STS Spacelab D1, 1985) 7-11

Turner, D. J.: Ionic Solutions Near the Critical Point of Water (TEXUS 10, 1984) 7-17
Turner, D. J.: Ionic Solutions Near the Critical Point of Water (TEXUS 12, 1985) 7-21

Beysens, D., et al.: Phase Separation in Binary Fluids- Spinodal Decomposition (TEXUS 11, 1985) 7-24
Beysens, D., et al.: Phase Separation in Binary Fluids-Spinodal Decomposition (TEXUS 13, 1986) 7-27

Principal Investigator Not Identified, Although Possibly, Beysens, D., et al:
Phase Separation of a Critical Mixture of Isobutyric Acid and Water (STS 51-G, 1985) 7-31

Klein, H.: Density Distributions and Phase Separation in Fluids at the Critical Point (STS Spacelab D1, 1985) 7-33
Klein, H.: Spinodal Decomposition (TEXUS 17, 1988) 7-36

Chapter 8
Crystal Growth From Solution

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Miyagawa, I., et al.: Rochelle Salt Growth (Skylab SL-4, 1973) 8-3

Grodzka, P. G.:, et al.: Deposition of Silver Crystals (Skylab SL-4, 1974) 8-7

Lind, M. D.: Crystal Growth (ASTP, 1975) 8-12
Lind, M. D., et al.: Growth of Crystals From Solutions in Low Gravity (STS 41-C, 1984) 8-17

Segawa, Y., et al.: Pb-Sn-Te Single Crystal Growth (TT-500A 10, 1981) 8-22
Segawa, Y., et al.: Pb-Sn-Te Single Crystal Growth (TT-500A 12, 1983) 8-24

Issel-Lyon, M. A., et al.: Crystal Growth of Tri-Glycine Sulfate (STS 31-A, 1982) 8-27

Pascherat, M., et al.: Crystal Growth in Liquid Salt Solution (STS 31-C, 1983) 8-30

Authier, A., et al.: Crystal Growth by Co-Precipitation in Liquid Phase (STS Spacelab 1, 1983) 8-34

Benz, K. W., et al.: Growth of Semiconductor Crystals by the Travelling Heater Method (Spacelab 1, 1983) 8-38
Benz, K. W., et al.: Travelling Heater Method-Te doped GaSb (STS Spacelab D1, 1985) 8-42
Benz, K. W., et al.: Travelling Heater Method-S doped InP (STS Spacelab D1, 1985) 8-45

Nielsen, K. F., et al.: Organic Crystal Growth (STS Spacelab 1, 1983) 8-48

Nitsche, R., et al.: Growth of Cadmium Telluride by Traveling Heater Method (STS Spacelab 1, 1983) 8-52

Crystal Growth From Solution

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Lee, J., et al.: Growth of KCN Crystals in Aqueous Solution (STS 41-G, 1984) 8-55

Lee, J., et al.: Growth of KCN Crystals in Aqueous Solution (STS 61-C, 1986) 8-58

Egbert, W. C.: Diffusive Mixing of Organic Solutions-Growth of Organic Crystals (DMOS-1) (STS 51-A, 1984) 8-63

Radcliffe, M. D., et al.: Diffusive Mixing of Organic Solutions (DMOS-2) (STS 61-B, 1985) 8-67

Lal, R. B., et al.: Fluid Experiment System (FES) Growth of Crystals in Solution (STS Spacelab 3, 1985) 8-74

Moore, M., et al.: Crystallization of Potassium-Aluminum-Sulfate (STS 51-G, 1985) 8-81

Haar, M.: Growth of PbSnTe by Travelling Heater Method (STS Spacelab D1, 1985) 8-84

Schönholz, R.: Growth of Cadmium Telluride from a Liquid Phase (Te Solution) by the Travelling Heater Method (STS Spacelab D1, 1985) 8-88

Vochten, R. F.: Crystal Growth From Solution (TEXUS 13, 1986) 8-92

Cavoli, S. R., et al.: Utilizing a Semi Permeable Membrane to Direct Crystal Growth (STS-26, 1988) 8-95

Rodriguez, N., et al.: Phenytoin Precipitation (Consort 1, 1989) 8-99

Schoonen, M., et al.: Inorganic Crystallization (Consort 1, 1989) 8-105

Chapter 9
Crystal Growth From the Melt

Listed Primarily Chronologically, but with Investigative Series of Principal Investigators Intact

Page

Witt, A. F., et al.: Apollo Indium Antimonide Remelt (Early Apollo) 9-3
Witt, A. F., et al.: Indium Antimonide Crystals (Skylab SL-3, 1973) 9-5
Witt, A. F., et al.: Indium Antimonide Crystals (Skylab SL-4, 1974) 9-9
Witt, A. F., et al.: Interface Marking in Crystals (ASTP, 1975) 9-14

Wilcox, W. R., et al.: Mixed III-V Crystal Growth (Skylab SL-3, 1973) 9-19
Wilcox, W. R., et al.: Mixed III-V Crystal Growth (Skylab SL-4, 1974) 9-25

Yue, A. S.: Halide Eutectic Growth (Skylab SL-3, 1973) 9-27
Yue, A. S., et al.: Halide Eutectic Growth (ASTP, 1975) 9-31

Yue, J. T., et al.: Microsegregation in Germanium (Skylab SL-3, 1973) 9-34

Facemire, B., et al.: Ice Formation (Skylab SL-4, 1974) 9-39

Papazian, J. M., et al.: Contained Polycrystalline Solidification (SPAR 1, 1975) 9-41
Papazian, J. M., et al.: Contained Polycrystalline Solidification (SPAR 4, 1977) 9-45
Papazian, J. M., et al.: Contained Polycrystalline Solidification (SPAR 5, 1978) 9-48

Lind, M. D., et al.: Epitaxial Growth of Single Crystal Film (SPAR 3, 1976) 9-51
Lind, M. D., et al.: Epitaxial Growth of Single Crystal Film (SPAR 6, 1979) 9-54

Chapter 9, Cont.
Crystal Growth From the Melt
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Hamakawa, Y.: Si-As-Te Amorphous Semiconductor (TT-500 A 8, 1980) 9-57
Hamakawa, Y.: Si-As-Te Amorphous Semiconductor (TT-500 A 9, 1981) 9-61
Hamakawa, Y.: Si-As-Te Amorphous Semiconductor (TT-500 A 10, 1981) 9-63
Hamakawa, Y.: Si-As-Te Amorphous Semiconductor (TT-500 A 11, 1982) 9-65
Hamakawa, Y.: Si-As-Te Amorphous Semiconductor (TT-500 A 12, 1983) 9-67

Walter, H. U.: Directional Solidification of Doped Semiconductors (TEXUS 4, 1981) 9-69
Walter, H. U.: Dotation Stripes in Germanium-Directional Solidification of Doped Semiconductors (TEXUS 6, 1982) 9-73

Eyer, A., et al.: Floating Zone Growth of Silicon (TEXUS 7, 1983) 9-76

Pierre, J.: Crystal Growth of Rare Earth-Magnesium Crystals (TEXUS 7, 1983) 9-79
Pierre, J.: Crystal Growth of Rare Earth Magnesium Crystals (TEXUS 12, 1985) 9-81

Kölker, H.: Crystallization of a Silicon Drop (STS Spacelab 1, 1983) 9-84
Kölker, H.: Crystallization of a Silicon Sphere (STS Spacelab D1, 1985) 9-88

Nitsche, R., et al.: Floating Zone Growth of Silicon (STS Spacelab 1, 1983) 9-91

Rodot, H.: Lead Telluride Crystal Growth (STS Spacelab 1, 1983) 9-95

Carlberg, T.: Floating Zone Growth of Ge Crystals From a Melt Zone (TEXUS 10, 1984) 9-98
Carlberg, T.: Floating Zone Experiments with Germanium Crystals (TEXUS 12, 1985) 9-101
Carlberg, T.: Floating Zone Experiments with Germanium Crystals (TEXUS 14a, 1986) 9-104

Chapter 9, Cont.
Crystal Growth From the Melt

Listed Primarily Chronologically, but with Investigative Series of Principal Investigators Intact

Page

Carlberg, T., et al.: Floating Zone Experiments with Germanium Crystals (TEXUS 14b, 1987) 9-106
Carlberg, T.: Semiconfined Bridgman Growth of Ga Doped Ge (MASER 2, 1988) 9-109

Murphy, S., et al.: Float Zone Single Crystal Growth of Indium (STS 41-D, 1984) 9-112

Cröll, A., et al.: Growth of a SiO_2 Coated Silicon Crystal from a Melt Zone (TEXUS 12, 1985) 9-117
Cröll, A., et al.: Floating Zone Crystallization of Silicon (STS Spacelab D1, 1985) 9-121

Billia, B., et al.: Cellular Morphology in Lead Thallium Alloys (STS Spacelab D1, 1985) 9-125

Crouch, R. K., et al.: Semiconductor Materials-Suppression of Body Force Gravity Driven Convection in Directionally Solidified PbTe-SnTe (STS Spacelab D1, 1985) 9-129

Potard, C., et al.: Growth Rate Measurement of Doped InSb Crystal by Method Under Microgravity (STS Spacelab D1, 1985) 9-134

Lipsett, F.: Cadmium Crystal Production (STS 61-B, 1985) 9-138

Redden, R., et al.: GEODE: Gravity Experiment on Detector Elements (MASER 1, 1987) 9-144

Müller, G.: GaAs Crystallization (TEXUS 15, 1987) 9-149
Müller, G.: GaAs Crystallization (TEXUS 16, 1987) 9-153

Camel, D., et al.: Semi-Confined Bridgman Growth of Ga Doped Ge (MASER 2, 1988) 9-156

Chapter 10
Crystal Growth From Vapor

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Rubenstein, M., et al.: Gallium Arsenide Crystal Growth (Skylab SL-2, 1973) 10-3

Wiedemeier, H.: Vapor Growth of II-VI Compounds (Skylab SL-3, 1973) 10-7

Wiedemeier, H. : Vapor Growth of II-VI Compounds (Skylab SL-4, 1974) 10-12

Wiedemeier, H., et al.: Crystal Growth from the Vapor Phase (ASTP, 1975) 10-16

Wiedemeier, H., et al.: Vapor Crystal Growth of Semiconductor Crystals (STS 31-C, 1983) 10-20

Wiedemeier, H.: Vapor Growth of Alloy-Type Crystals (STS Spacelab D1, 1985) 10-24

Kimura, S., et al.: Artificial Snowflake Experiment (STS 31-B, 1983) 10-28

Kimura, S., et al.: Artificial Snowflake Expt. (STS 31-D, 1983) 10-33

Cadoret, R., et al.: Crystal Growth of Mercury Iodide by Physical Vapor Transport (STS Spacelab 1, 1983) 10-38

Cadoret, R., et al.: Mercuric Iodide Crystal Growth (STS Spacelab 3, 1985) 10-43

McShane, J. W., et al.: Art in Space: Coating of Glass Spheres by Vacuum Deposition Techniques (STS 41-G, 1984) 10-46

Schnepple, W. F., et al.: Mercuric Iodide Vapor Crystal Growth System (VCGS) (STS Spacelab 3, 1985) 10-51

Debe, M., et al.: Physical Vapor Transport of Organic Solids (STS 51-I, 1985) 10-57

Debe, M., et al.: Physical Vapor Transport of Organic Solids (STS-26, 1988) 10-62

Bruder, M., et al.: Vapor Zone Crystallization of Cadmium Telluride (STS Spacelab D1, 1985) 10-65

Chapter 10, Cont.
Crystal Growth From Vapor
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Launay, J. C.: Solutal and Thermal Convection in GeI2 Vapor Phase (STS Spacelab D1, 1985).......... 10-68

Rey, D., et al.: Primary Mirror Production Using Vapor Deposition on a Quartz Plate (STS 61-B, 1985)...................................... 10-72

<u>Chapter 11</u>
<u>Diffusion</u>

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Facemire, B., et al.: <u>Diffusion in Liquids</u>
(Skylab SL-3, 1973).................................. 11-3
  Facemire, B.: Diffusion in Liquids
  (Skylab SL-4, 1974)......... 11-7

Ukanwa, A. O.: <u>Radioactive Tracer Diffusion</u>
(Skylab SL-3, 1973).................................. 11-9

Frischat, G. H., et al.: <u>Reaction Kinetics in Glass Melts</u> (TEXUS 1, 1977).......................... 11-13
  Frischat, G. H., et al.: Reaction Kinetics in Glass Melts (TEXUS 4, 1981)........................ 11-17
  Frischat, G. H., et al.: Reaction Kinetics in Glass Melts (TEXUS 6, 1982)......................... 11-21
  Frischat, G. H., et al.: Reaction Kinetics in Glass Melts (STS Spacelab 1, 1983).................. 11-24
  Frischat, G. H., et al.: Reaction Kinetics in Glass Melts (STS 41-B, 1984)....................... 11-28
  Frischat, G. H., et al.: Reaction Kinetics in Glass Melts (TEXUS 11, 1985)....................... 11-33
  Frischat, G. H., et al.: Reaction Kinetics in Glasses (TEXUS 12, 1985)........................... 11-37
  Frischat, G. H., et al.: <u>Homogeneity of Glasses</u> (STS Spacelab D1, 1985)............................ 11-40
  Frischat, G. H., et al.: Reaction Kinetics in Glasses (TEXUS 13, 1986)........................... 11-44
  Frischat, G. H., et al.: Reaction Kinetics in Glasses (TEXUS 15, 1987)........................... 11-48
  Frischat, G. H., et al.: <u>Self-Diffusion</u> (TEXUS 16, 1987).................................... 11-50
  Frischat, G. H., et al.: <u>Refraction Gradients in Glasses</u> (TEXUS 16, 1987)....................... 11-52

Merkens, W., et al.: <u>Diffusion Boundary</u>
(TEXUS 8, 1983)...................................... 11-55
  Merkens, W., et al.: <u>Inter-Diffusion of Molten Salts</u> (STS Spacelab D1, 1985)............... 11-58

Malmejac, Y., et al.: <u>Thermodiffusion in Tin Alloys</u> (STS Spacelab 1, 1983)........................ 11-62

Chapter 11, Cont.
Diffusion
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Wever, H., et al.: Self-Diffusion in Liquid Metals (STS Spacelab 1, 1983) 11-65

Wever, H., et al.: Self and Interdiffusion in Liquid Metals (Sn-In) (STS Spacelab D1, 1985) 11-70

Bert, J., et al.: Measurement of the Thermally Induced Ludwig-Soret Effect (STS Spacelab D1, 1985) 11-74

Pond, R. B., et al.: The Diffusion of Liquid Zinc and Lead (STS Spacelab D1, 1985) 11-79

Praizey, J. P., et al.: Thermodiffusion in Liquid Alloys (STS Spacelab D1, 1985) 11-82

Tensi, H. M., et al.: Aluminum/Copper Phase Boundary Diffusion - Solid-Liquid Interface Diffusion (STS Spacelab D1, 1985) 11-86

Köstler, C., et al.: Diffusion of Ni in CuAl and CuAu Alloys (TEXUS 16, 1987) 11-89

Fiske, M. R.: Solid-Liquid Diffusion (Consort 1, 1989) 11-91

Todd, P.: Turbulent Mixing and Dye Diffusion (Consort 1, 1989) 11-95

<Note: A related diffusion experiment entitled "Thermal Conductivity of Electrically Non-Conducting Liquids" can be found in Chapter 15: Physical Chemistry (See Aalto, MASER 1).>

Chapter 12
Fluid Physics

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Petrash, D. A., et al.: Effects of Acceleration Disturbances on the Liquid-Vapor Interface in a Baffled Tank (Mercury-Aurora 7, 1962)................ 12-3

Abdalla, K. L., et al.: Liquid Transfer Demonstration (Apollo 14, 1971)................................ 12-7

Bannister, T. C., et al.: Heat Flow and Convection (Apollo 14, 1971).......................... 12-13

Bannister, T. C., et al.: Heat Flow and Convection (Apollo 17, 1972)....................... 12-18

Sherhart, K. M., et al.: Powder Flow (Skylab)......... 12-22

Dunlap, B., et al.: Liquid Motion (Skylab SL-3, 1973).................................. 12-24

Grodzka, P. G., et al.: Water Studies, Physics of a Water Globule (Skylab SL-3, 1973).................. 12-27

Carruthers, J., et al.: Liquid Floating Zone (Skylab SL-4, 1973).................................. 12-30

Darbro, W.: Liquid Films (Skylab SL-4, 1974).......... 12-34

Hibbs, A. R., et al.: Effervescence (Skylab SL-4).. 12-38

Oran, W. A., et al.: Lens Formation (Skylab SL-4)..... 12-40

Vaughan, O.: Cloud Formation (Skylab SL-4, 1973)...... 12-42

Vaughan, O., et al.: Water Drop and Fluid Mechanic Series (Skylab SL-4, 1973)................ 12-46

Vaughan, O., et al.: Acoustic Positioning (Skylab SL-4)....................................... 12-50

Bourgeois, S. V., et al.: Spreading of Liquids (ASTP, 1975)... 12-53

Reed, R. E., et al.: Surface Tension Induced Convection (ASTP, 1975)............................ 12-56

<u>Chapter 12, Cont.</u>
<u>Fluid Physics</u>
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Papazian, J. M., et al.: <u>Thermal Migration of Bubbles and Their Interaction with Solidification Interfaces</u> (SPAR 1, 1975) 12-60
Papazian, J. M., et al.: Thermal Migration of Bubbles and Their Interaction with Solidification Interfaces (SPAR 3, 1976) 12-65

Schafer, C. F.: <u>Characterization of Rocket Vibration Environment by Measurement of the Mixing of Two Liquids</u> (SPAR 1, 1975) 12-71
Schafer, C. F., et al.: <u>Liquid Mixing</u> (SPAR 3, 1976) 12-74

Uhlmann, D. R.: <u>Contact and Coalescence of Viscous Bodies</u> (SPAR 3, 1976) 12-77

Wang, T. G., et al.: <u>Containerless Processing Technology</u> (SPAR 4, 1977) 12-79
Wang, T. G., et al.: Containerless Processing Technology (SPAR 6, 1979) 12-82
Wang, T. G., et al.: Containerless Processing Technology-Liquid Drops (SPAR 7, 1980) 12-86
Wang, T. G., et al.: Containerless Processing Technology-Liquid Bubbles (SPAR 7, 1980) 12-90
Wang, T. G., et al.: Dynamics of Liquid Bubbles (SPAR 8, 1980) 12-93
Wang, T. G., et al.: Containerless Processing Technology (SPAR 10, 1983) 12-96
Wang, T. G., et al.: Dynamics of Rotating and Oscillating Free Drops (STS Spacelab 3, 1985) 12-98
Wang, T. G., et al.: Three-Axis Acoustic Levitator (STS 61-C, 1986) 12-103

Brückner, R.: <u>Interfacial Convection</u> (TEXUS 1, 1977) 12-105
Brückner, R.: Interfacial Convection (TEXUS 2, 1978) 12-109
Brückner, R.: Diffusion-Induced Interfacial Convection (TEXUS 3, 1980) 12-113
Brückner, R.: Diffusion-Induced Interfacial Convection (TEXUS 3b, 1981) 12-115

Chapter 12, Cont.
Fluid Physics
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Brückner, R.: Temperature-Gradient Induced Interfacial Convection (TEXUS 4, 1981)............. 12-118
Brückner, R., et al.: Thermally-Induced Interface Convection (TEXUS 6, 1982)................ 12-121
Brückner, R., et al.: Diffusion-Induced Interface Convection (TEXUS 8, 1983)................ 12-123
Brückner, R., et al.: Diffusion-Induced Interface Convection (TEXUS 11, 1985)............... 12-126

Chun, Ch.-H., et al.: Marangoni Convection in Float Zones (TEXUS 3, 1980).......................... 12-129
Chun, Ch.-H., et al.: Marangoni Convection in Float Zones (TEXUS 3b, 1981)........................ 12-131
Chun, Ch.-H., et al.: Oscillatory Convection in Float Zones (TEXUS 7, 1983)........................ 12-135

Schwabe, D., et al.: Critical Marangoni Number--Temperature Oscillations in Float Zones (TEXUS 3, 1980)....................................... 12-139
Schwabe, D., et al.: Critical Marangoni Number--Temperature Oscillations in Float Zones (TEXUS 3b, 1981).................................. 12-144
Schwabe, D., et al.: Critical Marangoni Number--Temperature Oscillations in Float Zones (TEXUS 5, 1982)................................... 12-149
Schwabe, D., et al.: Critical Marangoni Number--Temperature Oscillations in Float Zones (TEXUS 8, 1983)................................... 12-153
Schwabe, D., et al.: Critical Marangoni Number (STS 31-C, 1983)................................. 12-157
Schwabe, D., et al.: Marangoni Convection in an Open Boat (STS Spacelab D1, 1985)................ 12-162

Wilcox, W. R., et al.: Glass Fining Experiment in Low-Gravity (SPAR 8, 1980)........................ 12-167

Elwell, J. K., et al.: Surface Tension Experiment-Shape of Liquid Meniscus (STS OFT-4, 1982)........... 12-172

Fluid Physics

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Haynes, J. M.: Interfacial Phenomena (STS 31-A, 1982) 12-175
Haynes, J. M.: Kinetics of Spreading of Liquids in Solids (STS 41-A, 1983) 12-178
Haynes, J. M.: Interfacial Instability and Capillary Hysteresis (STS Spacelab 1, 1983) 12-181

Thomas, S., et al.: Surface Tension Convection (STS 31-A, 1982) 12-184
Thomas, S., et al.: Thermocapillary Convection (STS 41-B, 1984) 12-187
Thomas, S., et al.: Thermocapillary Convection-Float Zone (STS 41-G, 1984) 12-190

Legros, J. C., et al.: Effects of Surface Tension Minimum on Thermocapillary Convection (TEXUS 8, 1983) 12-194
Legros, J. C.: Effects of Surface Tension Minimum on Thermocapillary Convection (TEXUS 9, 1984) 12-198
Legros, J. C.: Surface Tension Induced Convection Around a Surface Tension Minimum (STS Spacelab D1, 1985) 12-201
Legros, J. C., et al: Effects of Surface Tension Minimum on Thermal Marangoni Convection in a Floating Zone (TEXUS 13, 1986) 12-206
Legros, J. C.: Surface Tension Minimum (TEXUS 15, 1987) 12-209
Legros, J. C.: Influence of a Surface Tension Minimum on the Marangoni Effect (TEXUS 16, 1987) 12-211

Perez, R., et al.: Motion of Mercury Under Low-G (STS 31-C, 1983) 12-213

Napolitano, L. G., et al.: Free Convection in Low-Gravity (STS Spacelab 1, 1983) 12-217
Napolitano, L. G., et al.: Marangoni Flows (STS Spacelab D1, 1985) 12-222

Rodot, H., et al.: Oscillation of Semi-Free Liquid in Space (STS Spacelab 1, 1983) 12-226

Chapter 12, Cont.
Fluid Physics

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Vreeburg, J.P.B.: Liquid Motions in Partially Filled Containers (STS Spacelab 1, 1983) 12-229
Vreeburg, J.P.B.: Liquid Motions in Partially Filled Containers (STS Spacelab D1, 1985) 12-233

Monti, R.: Thermal Marangoni Convection in a Floating Zone (TEXUS 9, 1984) 12-237
Monti, R., et al.: Thermal Marangoni Convection in a Floating Zone (TEXUS 14a, 1986) 12-240
Monti, R., et al.: Thermal Marangoni Convection in a Floating Zone (TEXUS 14b, 1987) 12-243

Asahi National Broadcasting Company, Ltd., et al.: Physics of Solids and Liquids (STS 41-G, 1984) 12-246
Asahi National Broadcasting Company, Ltd., et al.: Physics of Solids and Liquids (STS 51-D, 1985) 12-249

McDonnell Douglas Astronautics Company, et al.: Zero G Fuel System Test: (A) Surface Tension Propellant Tank Test and (B) Inertial-Driven Propellant Transfer Demonstration (STS 41-G, 1984) 12-252

Tegart, J., et al.: Storable Fluid Management Demonstration (STS 51-C, 1985) 12-256

Hart, J. E., et al.: Geophysical Fluid Flow Cell (STS Spacelab 3, 1985) 12-260

Messerschmitt-Boelkow-Blohm (MBB/ERNO), et al.: Liquid Sloshing: Dynamic Behavior of Liquid Propellants (STS 51-G, 1985) 12-264

Fazio, G. G., et al.: Small Helium-Cooled Infrared Telescope (STS Spacelab 2, 1985) 12-271

Mason, P. V., et al.: Super Fluid Helium Experiment (STS Spacelab 2, 1985) 12-275

Bewersdorff, A.: Bubble Transport by Chemical Waves (STS Spacelab D1, 1985) 12-280

Chapter 12, Cont.
Fluid Physics

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Drinkenburg, A.A.H., et al.: Marangoni Convection in Relation to Mass Transfer From the Liquid to the Gas Phase (STS Spacelab D1, 1985) 12-284

Nähle, R., et al.: Separation of Fluid Phases and Bubble Dynamics in a Temperature Gradient (STS Spacelab D1, 1985) 12-289

Neuhaus, D., et al.: Bubble Motions Induced by Temperature Gradient (STS Spacelab D1, 1985) 12-294

Rice, J., et al.: Terminal Velocity Experiment (STS 61-C, 1986) 12-298

Thames, M., et al.: Liquid Sloshing Experiment (STS 61-C, 1986) 12-301

Wesley, F., et al.: Fluid/Air Interaction Experiment (STS 61-C, 1986) 12-305

Lichtenbelt, J. H., et al.: Three-Dimensional Marangoni Convection (MASER 1, 1987) 12-307

Wozniak, G., et al.: Thermocapillary Drop Motion (MASER 1, 1987) 12-311

Wozniak, G., et al.: Thermocapillary Drop Motion (MASER 2, 1988) 12-316

Janssen, L.P.B.M, et al.: Three-Dimensional Marangoni Convection (MASER 2, 1988) 12-321

Chapter 13
Liquid Phase Sintering

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Rossito, F.: Liquid Phase Sintering
(TEXUS 8, 1983).. 13-3

Fredriksson, H., et al.: Composites From High
Temperature Melting Point Alloys (TEXUS 10, 1984).... 13-6

Graf, W.: Liquid Phase Sintering
(TEXUS 12, 1985).. 13-11

Rogge, V.: Liquid Phase Sintering (TEXUS 15, 1987).... 13-14
Rogge, V.: Liquid Phase Sintering
(TEXUS 16, 1987).. 13-16

Ekbom, L. B., et al.: Liquid Phase Sintering
(TEXUS 16, 1987).. 13-18

Smith, J. E., et al.: Metal Sintering Furnace
(Consort 1, 1989).. 13-21

Chapter 14
Metals and Alloys
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Poorman, R. M., et al.: Metals Melting (Skylab SL-2, 1973) 14-3

Hasemeyer, E. A., et al.: Copper-Aluminum Eutectic (Skylab SL-3, 1973) 14-8
Hasemeyer, E. A., et al.: Copper-Aluminum Eutectic (Skylab SL-4, 1974) 14-11

Heye, W., et al.: Preparation of a Special Alloy For Manufacturing of Magnetic Hard Superconductors Under a Zero-Gravity Environment (SPAR 1, 1975) 14-15

Johnston-McCay, M. H., et al.: Direct Observation of Solidification as a Function of Gravity (SPAR 1, 1975) 14-19
Johnston-McCay, M. H., et al.: Direct Observation of Dendritic Remelting and Macrosegregation in Castings (SPAR 2, 1976) 14-23
Johnston-McCay, M. H., et al.: The Direct Observation of Dendritic Remelting and Macrosegregation in Casting (SPAR 5, 1978) 14-26
Johnston-McCay, M. H., et al.: Comparative Alloy Solidification (SPAR 7, 1980) 14-29
Johnston-McCay, M. H., et al.: Comparative Alloy Solidification (SPAR 9, 1981) 14-32
Johnston-McCay, M. H., et al.: Comparative Alloy Solidification (SPAR 10, 1983) 14-35

Pond, R. B., et al.: Solidification of Pb-Sb Eutectic (SPAR 1, 1975) 14-38
Pond, R. B., et al.: Solidification of Pb-Sb Eutectic (SPAR 2, 1976) 14-42

Fredriksson, H.: Dendritic Growth and Segregation Phenomena: Eutectic Al-Cu and Hypereutectic Al-Cu (TEXUS 1, 1977) 14-46
Fredriksson, H.: Dendritic Growth and Segregation Phenomena: Eutectic Sn-Zn (TEXUS 1, 1977) 14-49
Fredriksson, H.: Isothermal Solidification of Eutectic Al-Si Alloy (TEXUS 2, 1978) 14-52
Fredriksson, H.: Dendritic Growth and Segregation Phenomena (TEXUS 7, 1983) 14-55

Chapter 14, Cont.
Metals and Alloys

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Fredriksson, H.: Dendritic Growth and Microsegregation (STS Spacelab 1, 1983)............. 14-57
Fredriksson, H.: Unidirectional Solidification of Sn-Al Samples (TEXUS 10, 1984)................... 14-59
Fredriksson, H., et al.: Precipitation in Ag-Sn System/Microgravity Growth of Eutectics (Ag-Sn) (MASER 1, 1987)............................. 14-61
Fredriksson, H., et al: Primary Precipitated Crystal in Directional Solidification Al-Cu (MASER 2, 1988)................................... 14-65

Haessner, F., et al.: Alloy Formation (TEXUS 2, 1978)... 14-69
Haessner, F., et al.: Alloy Formation (TEXUS 5, 1982)................................... 14-73

Principal Investigator Unknown: Solidification of Al-Ti (TEXUS 2, 1978)................................. 14-76

Principal Investigator Unknown: Solidification (TEXUS 2, 1978)... 14-78

Principal Investigator Unknown, although possibly Fredriksson, H.: Isothermal Solidification of Eutectic Al-Si Alloy (TEXUS 2, 1978)............... 14-80

Favier, J. J., et al.: Directional Solidification of Al_2-Cu-Al Eutectics (TEXUS 4, 1981)................ 14-82
Favier, J. J., et al.: Directional Solidification of (1) Al_3-Ni-Al Eutectics and (2) Al_2Cu Al-Eutectics (TEXUS 6, 1982)....................... 14-85
Favier, J. J., et al.: Unidirectional Solidification of Eutectic Alloys (STS Spacelab 1, 1983)............................. 14-89
Favier, J. J., et al.: Dendritic Solidification of Aluminum-Copper Alloys (STS Spacelab D1, 1985)... 14-93

Luyendijk, T., et al.: Sulfur Diffusion in Liquid Cast Iron (TEXUS 6, 1982)............................ 14-97
Luyendijk, T., et al.: Unidirectional Solidification of Cast Iron (STS Spacelab 1, 1983).......... 14-100

Chapter 14, Cont.
Metals and Alloys

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Thomas, T. L., et al.: Eutectic Formation (STS OFT-4, 1982) 14-105

Amidon, J. M., et al.: Immiscible Alloy Solidification (Sn-Pb) (STS 31-B, 1983) 14-109

Streb, J. M., et al.: Zone Refining Purification (STS 31-B, 1983) 14-112

Carlberg, T.: Examination of Floating Zones in a Mirror Furnace (TEXUS 7, 1983) 14-114

Klein, H., et al.: Particle Transport Induced by Directional Solidification (STS 31-C, 1983) 14-116

Ghersini, G., et al.: Adhesion of Metals (STS Spacelab 1, 1983) 14-120

Malmejac, Y., et al.: Nucleation Behavior of Eutectic Alloys (STS Spacelab 1, 1983) 14-124
Malmejac, Y., et al.: Nucleation of Eutectic Alloys (STS Spacelab D1, 1985) 14-126

Müller, G.: Unidirectional Solidification of Eutectics (InSb-NiSb) (STS Spacelab 1, 1983) 14-128
Müller, G.: Directional Solidification of InSb-NiSb Eutectic (TEXUS 10, 1984) 14-131
Müller, G.: Directional Solidification of InSb-NiSb Eutectic (STS Spacelab D1, 1985) 14-134

Ecker, A., et al.: Boundary Layer in Solidifying Transparent Melts (TEXUS 10, 1984) 14-137
Ecker, A., et al.: GETS-Boundary Layers in Solidifying Transparent Melts (STS Spacelab D1, 1985) 14-141

Metals and Alloys

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Asahi National Broadcasting Company, Ltd., et al.: (1) Indium Antimony Crystal Production, (2) Lead Zinc Alloy Production and (3) Glass Composite Production (STS 41-G, 1984) 14-145

Asahi National Broadcasting Company, Ltd., et al.: (1) Indium Antimony Crystal Production, (2) Lead-Zinc Alloy Production, and (3) Glass Composite Production (STS 51-D, 1985) 14-148

Henderson, A. J., Jr., et al.: Solidification of Lead-Antimony and Aluminum-Copper Alloys (STS 41-G, 1984) 14-150

Henderson, A. J., Jr., et al.: Study of Solidification of Alloys in Zero-G (STS 61-C, 1986) 14-153

Rex, S., et al: Solidification Front Convection (STS Spacelab D1, 1985) 14-159

Larson, D. J., Jr.: Directional Solidification of Magnetically Aligned CoSm Composites (STS 61-C, 1986) 14-163

Bruce, L. C., et al.: Effects of Weightlessness on Grain Formation and Strength in Metals (STS-26, 1988) 14-167

Chapter 15
Physical Chemistry/Phase Transition

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Merkel, G. A., et al.: Brownian Motion (Skylab) 15-3

Otto, G. H., et al.: Ice Melting (Skylab SL-3, 1973) .. 15-5

Ehrhardt, J., et al.: Dispersion Electrolysis (TEXUS 1, 1977) 15-10
Ehrhardt, J.: Dispersion Electrolysis (TEXUS 4, 1981) 15-13
Ehrhardt, J., et al.: Dispersion Electrolysis (TEXUS 7, 1983) 15-16
Ehrhardt, J.: Dispersion Electrolysis (TEXUS 9, 1984) 15-19

Raub, C. J., et al.: Cathodic Hydrogen Formation (TEXUS 1, 1977) 15-22
Raub, C. J.: Cathodic Hydrogen Formation/ Bubble Electrolysis (TEXUS 6, 1982) 15-24

Mix, G.: Electrochemical Corrosion (TEXUS 2, 1978) 15-26

Straub, J., et al.: Nucleate Pool Boiling (TEXUS 3, 1980) 15-30
Straub, J., et al.: Bubble Formation: Nucleate Pool Boiling (TEXUS 3b, 1981) 15-32
Straub, J., et al.: Bubble Formation (TEXUS 5, 1982) 15-36
Straub, J., et al.: Bubble Formation (TEXUS 8, 1983) 15-39
Straub, J., et al.: Bubble Formation (TEXUS 10, 1985) 15-41
Straub, J., et al.: Bubble Formation (TEXUS 11, 1985) 15-44
Straub, J., et al.: Single Bubble (TEXUS 13, 1986) 15-49

Riepl, H., et al.: Nickel Catalyst (STS 31-C, 1983) 15-53

Gadsden, M., et al.: Three-Dimensional Brownian Motion (STS 41-B, 1984) 15-57

Chapter 15, Cont.
Physical Chemistry/Phase Transition

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Kedzierski, M., et al.: Convection Experiment (STS 61-C, 1986) 15-60

Richter, J., et al.: Ultrasonic Absorption in Molten Salts (TEXUS 14a, 1986) 15-63
- Richter, J., et al.: Ultrasonic Absorption in Molten Salts (TEXUS 14b, 1987) 15-66
- Richter, J., et al.: Ultrasonic Absorption in Molten Salts (TEXUS 17, 1988) 15-69

Aalto, S., et al.: Thermal Conductivity of Electrically Non-Conducting Liquids MASER 1, 1987) 15-72

Stein, H. N.: Colloidal Chemistry (TEXUS 15, 1987) 15-76
- Stein, H. N., et al.: Colloidal Chemistry (TEXUS 17, 1987) 15-78

Riley, C., et al.: Electrodeposition of Cells/ Electrocodeposition of Cells (Consort 1, 1989) 15-81

Chapter 16
Protein Crystal Growth

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Littke, W.: Diffusion and Growing of Protein Beta Galactosidase Crystals (TEXUS 3, 1980) 16-3

Littke, W.: Diffusion and Growing of Protein Beta Galactosidase Crystals (TEXUS 3b, 1981) 16-5

Littke, W.: Diffusion and Growing of Protein Beta Galactosidase Crystals (TEXUS 4, 1981) 16-8

Littke, W.: Diffusion and Growing of Protein Beta Galactosidase Crystals (TEXUS 5, 1982) 16-10

Littke, W.: Crystal Growth of Proteins (STS Spacelab 1, 1983) 16-12

Littke, W.: Protein Single Crystal Growth Under Zero Gravity (STS Spacelab D1, 1985) 16-15

Gerpheide, G. E., et al.: Crystallization of Proteins (STS 41-B, 1984) 16-18

Walker, C., et al.: Protein Liquid Diffusion Experiment (STS 41-D, 1984) 16-22

Bugg, C. E., et al.: Human Protein Crystal Growth (PCG) Experiment (STS 51-D, 1985) 16-25

Bugg, C. E., et al.: Human Protein Crystal Growth Experiment (STS Spacelab 2, 1985) 16-31

Bugg, C. E., et al.: Human Protein Crystal Growth Experiment (STS 61-B, 1985) 16-37

Bugg, C. E., et al.: Human Protein Crystal Growth Experiment (STS 61-C, 1986) 16-42

Bugg, C. E., et al.: Protein Crystal Growth (STS-26, 1988) 16-48

Bugg, C. E., et al.: Protein Crystal Growth (STS-29, 1989) 16-53

Bugg, C. E., et al.: Protein Crystal Growth (STS-32, 1990) 16-58

Wagner, G.: Bacteriorhodopsin- A Membrane Protein to Convert Light Energy (STS Spacelab D1, 1985) 16-63

Burgess, R., et al.: Protein Diffusion (Consort 1, 1989) 16-65

Chapter 16, Cont.
Protein Crystal Growth
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Cassanto, J., et al.: Protein Crystal Stability
(Consort 1, 1989)...................................... 16-70

Chapter 17
Systems Exhibiting a Miscibility Gap

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

	Page
Reger, J. L., et al.: Composite Casting- Part III Paraffin-Based Immiscible Samples (Apollo 14, 1971)...	17-3
Reger, J. L., et al.: Immiscible Alloy Compositions (Skylab SL-3, 1973)....................	17-6
Reger, J. L., et al.: Immiscible Alloy Compositions (Skylab SL-4, 1973)....................	17-11
Lacy, L. L., et al.: Immiscible Liquids (Skylab SL-4, 1974)..................................	17-14
Lacy, L. L., et al.: Monotectic and Synthetic Alloys (ASTP, 1975)................................	17-18
Larson, D. J., Jr.: Zero-G Processing of Magnets (ASTP, 1975)..................................	17-22
Larson, D. J., Jr.: Directional Solidification of Magnetically Aligned BiMn Alloy (STS 51-G, 1985)...................................	17-26
Larson, D. J., Jr.: Directional Solidification of a Magnetic Composite Using the Automated Directional Solidification Furnace (STS-26, 1988)...	17-30
Gelles, S. H., et al.: Agglomeration in Immiscible Liquids (SPAR 2, 1976)..................................	17-34
Gelles, S. H., et al.: Agglomeration in Immiscible Liquids (SPAR 5, 1978)..................	17-38
Gelles, S. H., et al.: Liquid Phase Miscibility Gap: (1) Gradient Cooling Experiment and (2) Isothermal Plunger Experiment (STS 31-C, 1983)......	17-43
Gelles, S. H.: Liquid Phase Miscibility Gap Materials (STS Spacelab D1, 1985)..................	17-48
Löhberg, K., et al.: Solidification Behavior of Al-In Immiscible Alloys Under Zero-Gravity Conditions (SPAR 2, 1976)............................	17-51
Hodes, E., et al.: Al-Pb Dispersion (TEXUS 1, 1977).......................................	17-56

Chapter 17, Cont.
Systems Exhibiting a Miscibility Gap
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Walter, H. U., et al.: Stability of Compound Mixtures/Powder Metallurgy (TEXUS 1, 1977)............ 17-59
Walter, H. U., et al.: Stability of Compound Mixtures/Powder Metallurgy (TEXUS 2, 1978).......... 17-63
Walter, H. U., et al.: Stability of Compound Mixtures (TEXUS 3, 1980)............................ 17-66
Walter, H. U., et al.: Stability of Compound Mixtures (TEXUS 3b, 1981).......................... 17-69
Walter, H. U., et al.: Stability of Compound Mixtures (TEXUS 5, 1982)........................... 17-72
Walter, H. U., et al.: Stability of Dispersions in Metallic Systems with Miscibility Gaps (TEXUS 7, 1983)................................... 17-75

Fredriksson, H.: Unidirectional Solidification of a Monotectic Pb-Cu Alloy (TEXUS 2, 1978)........... 17-80
Fredriksson, H.: Segregation Phenomena in Immiscible Alloys: Zn-Bi Alloys (TEXUS 2, 1978)..... 17-82
Fredriksson, H., et al.: Isothermal Solidification of Zn-Pb (TEXUS 2, 1978)..................... 17-86
Fredriksson, H.: Immiscible Alloys (TEXUS 3, 1980)...................................... 17-88
Fredriksson, H.: Immiscible Alloys (TEXUS 3b, 1981)..................................... 17-90
Fredriksson, H.: The Coalescence Process in Immiscible Alloys (TEXUS 5, 1982).................. 17-92
Fredriksson, H.: Unidirectional Solidification of Immiscible Alloys (TEXUS 5, 1982)................ 17-95
Fredriksson, H., et al.: Unidirectional Solidification of Immiscible Alloys (TEXUS 7, 1983)......... 17-99
Fredriksson, H., et al.: Unidirectional Solidification of Zn-Bi Samples (TEXUS 12, 1985)........... 17-102
Fredriksson, H.: Unidirectional Solidification of Zn-Bi Samples (TEXUS 14a, 1986)................. 17-105
Fredriksson, H.: Coalescence Process of Immiscible Alloys (MASER 1, 1987).................. 17-107
Fredriksson, H., et al.: Unidirectional Solidification of Zn-Bi Samples (TEXUS 14b, 1987).......... 17-110
Fredriksson, H., et al.: A Study of the Coalescence Process of Immiscible Alloys in Large Samples (MASER 2, 1988)........................... 17-113

Chapter 17, Cont.
Systems Exhibiting a Miscibility Gap
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Fredriksson, H., et al.: Gradient Solidification of Immiscible Alloys, Zn-Pb (MASER 2, 1988)......... 17-116

Pant, P., et al.: Fundamental Studies of the Manganese-Bismuth System (TEXUS 2, 1978).............. 17-120
Pant, P., et al.: Fundamental Studies of the Manganese-Bismuth System (STS 31-C, 1983)........... 17-125
Pant, P., et al.: Fundamental Studies of the Manganese-Bismuth System (STS 51-G, 1985)........... 17-128

Pirich, R. G., et al.: Directional Solidification of Magnetic Composites (SPAR 6, 1979).................... 17-133
Pirich, R. G.: Directional Solidification of Magnetic Composites (SPAR 9, 1981).................. 17-136

Potard, C., et al.: Directional Solidification of Immiscible Aluminum Indium Alloys (SPAR 9, 1981)...... 17-139

Heide, W., et al.: Acoustic Mixing (TEXUS 5, 1982).... 17-142
Heide, W., et al.: Separation of Transparent Liquids (TEXUS 7, 1983)............................ 17-146
Heide, W., et al.: Acoustic Mixing/Solidification of Immiscible Alloys (TEXUS 8, 1983)................ 17-149
Heide, W., et al.: Separation of Transparent Liquids (TEXUS 9, 1984)............................ 17-152

Laher, R. R., et al.: Thermal Conductivity of a Binary Heterogeneous Mixture (STS OFT-4, 1982)........ 17-155

Otto, G. H.: Stability of Metallic Dispersions (STS 31-A, 1982).. 17-159
Otto, F. H.: The Stability of Metallic Dispersions (STS 31-C, 1983)........................ 17-163

Caton, P. D., et al.: Solidification of Al-Pb Alloys Under Microgravity (TEXUS 7, 1983).............. 17-169
Caton, P. D., et al.: Metallic Emulsions Al-Pb (STS Spacelab 1, 1983).................................. 17-172

Bethin, J.: Directional Solidification of Magnetic Composites (SPAR 10, 1983).................... 17-175

Chapter 17, Cont.
Systems Exhibiting a Miscibility Gap
Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Bennit, C.: Separation of Oil and Water (STS 31-C, 1983) 17-178

Kamio, A., et al.: Al-In: Acoustic Mixing in an Electric Furnace/Graphite Crucible (TT-500A 13, 1983) 17-181

Ahlborn, H., et al.: Solidification of Immiscible Alloys (STS Spacelab 1, 1983) 17-183
Ahlborn, H.: Separation of Immiscible Melts (STS Spacelab D1, 1985) 17-187

Fischmeister, H., et al.: Solidification of Near Monotectic ZnPb Alloys (STS Spacelab 1, 1983) 17-191
Fischmeister, H.: Ostwald Ripening in Metallic Melts- Interfacial Phenomena and Transport Processes in Binary Monotectic Alloys (STS Spacelab D1, 1985) 17-196

El-Faer, M. L., et al.: Phase Separation Experiment (STS 51-G, 1985) 17-199

Langbein, D., et al.: Mixing and Demixing of Transparent Liquids (STS Spacelab D1, 1985) 17-205

Bach, H., et al.: Separation of Monotectics of Lanthanide Elements Under Microgravity (TEXUS 13, 1986) 17-210

Togano, K., et al.: Fabrication of Superconducting Materials (TEXUS 13, 1986) 17-214

Passerone, A., et al.: Meniscus Stability In Immiscibles (MASER 1, 1987) 17-217

Prinz, B., et al.: Separation of Monotectic Ternary Alloys (TEXUS 15, 1987) 17-222
Prinz, B., et al.: Separation of Monotectic Ternary Alloys (TEXUS 16, 1987) 17-224

Systems Exhibiting a Miscibility Gap

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Harris, J. M., et al.: Demixing of Immiscible Polymers (Consort 1, 1989)............................ 17-226

Harris, J. M., et al.: Elastomer-Modified Epoxy Resins Heater (Consort 1, 1989)............... 17-230

Chapter 18
Technological Experiments

Listed Primarily Chronologically by Topic,
but with Investigative Series of Principal Investigators Intact

Page

Brazing

Williams, J. R.: Exothermic Brazing
(Skylab SL-2, 1973) 18-3

Bathke, W., et al.: Capillary Brazing
(TEXUS 2, 1978) 18-8

Frieler, K., et al.: Vacuum Brazing
(STS Spacelab 1, 1983) 18-12

Kozma, L., et al.: Adhesion of Metals on Ceramic Substrates (MASER 2, 1988) 18-15

Soldering

Carlberg, T.: Soldering of Sn-Ag Between Cu Tubes
(TEXUS 5, 1982) 18-19

Alford, G. C., et al.: Soldering (STS OFT-4, 1982) 18-22
- Alford, G. C., et al.: Soldering Experiment (STS 41-B, 1984) 18-25

Gross, H. N., et al.: Metal Beam Joiner
(STS 31-B, 1983) 18-28

EDSYN, Inc., et al.: Solder Flux Selection Test
(STS 31-C, 1983) 18-31
- EDSYN, Inc., et al.: Solder Wetting and Surface Tension I (STS 31-C, 1983) 18-34
- EDSYN, Inc., et al.: Wetting and Surface Tension II: Solder Flow and Bridging Test (STS 31-C, 1983) 18-37
- EDSYN, Inc., et al.: Metallurgical Properties: Eyelet and Post Soldering Test (STS 31-C, 1983) 18-40
- EDSYN, Inc., et al.: Solder Removal: Integrated Circuit Removal Test (STS 31-C, 1983) 18-43
- EDSYN, Inc., et al.: Desoldering II: Pressure Desoldering Demo (STS 31-C, 1983) 18-46
- EDSYN, Inc., et al.: Electronically Controlled Solder Tip Demo With Flux (STS 31-C, 1983) 18-49

Page

Soldering, Cont.

EDSYN, Inc., et al.: Electronically Controlled Solder Tip Demo Without Flux (STS 31-C, 1983) 18-52
EDSYN, Inc., et al.: Product Exposure Test (STS 31-C, 1983) 18-55

Unidentified Principal Investigator, et al.: Solder-Flux Separation (STS 41-G, 1984) 18-58

Mass Measurement

Converse, V. W., et al.: Zero-Gravity Mass Measurement (Skylab SL-3, 1973) 18-61

Acoustic Positioning Hardware Evaluation
For Experimental Analyses of Samples Performed in a Variety of Containerless Processing Facilities, Refer to the Containerless Processing Chapter.

Lierke, E. G.: Acoustic Positioning (TEXUS 1, 1977) ... 18-64
Lierke, E. G.: Acoustic Positioning (TEXUS 9, 1984) 18-67
Lierke, E. G.: Acoustic Positioning (TEXUS 14a, 1986) 18-71
Lierke, E. G.: Acoustic Positioning (TEXUS 14b, 1987) 18-73

Skin Technology

Sprenger, H., et al.: Skin Technology (TEXUS 1, 1977) 18-77
Sprenger, H., et al.: Skin Technology (TEXUS 2, 1978) 18-82
Sprenger, H., et al.: Skin Technology (TEXUS 3, 1980) 18-86
Sprenger, H., et al.: Skin Technology (TEXUS 3b, 1981) 18-89

Page

Skin Technology, Cont.

Sprenger, H., et al.: Skin Technology (TEXUS 4, 1981)...................................... 18-92
Sprenger, H., et al.: Skin Technology (TEXUS 5, 1982)...................................... 18-95
Sprenger, H., et al.: Skin Technology (TEXUS 7, 1983)...................................... 18-97
Sprenger, H., et al.: Skin Technology (STS Spacelab 1, 1983).............................. 18-99
Sprenger, H., et al.: Skin Technology (TEXUS 9, 1984)...................................... 18-102
Sprenger, H.: Protective Film Engineering: Skin Technology (TEXUS 11, 1985).................... 18-105
Sprenger, H.: Protective Film Engineering: Skin Technology (TEXUS 12, 1985).................... 18-108
Sprenger, H.: Skin Technology/Eutectic Solidification (STS Spacelab D1, 1985).............. 18-111
Sprenger, H.: Skin Casting on Grey Cast Iron (STS Spacelab D1, 1985)............................ 18-116
Sprenger, H.: Dispersion Alloys (TEXUS 15, 1987).... 18-121
Sprenger, H.: Dispersion Alloys (TEXUS 16, 1987).... 18-123

Halogen Lamp and Metal-Halide Arc Lamp Performance

Eyer, A., et al.: Halogen Lamp Performance (TEXUS 3, 1980).. 18-125
Eyer, A., et al.: Halogen Lamp Performance (TEXUS 3b, 1981).................................... 18-127

NASDA: Halogen Lamp (TT-500A 12, 1983)................ 18-129

Bellows, A. H., et al.: Study of Convection-Free Metal Halide Lamps (STS 41-B, 1984).................. 18-131

Kayser-Threde GmbH, et al.: Halogen Lamp Experiment (STS 41-G, 1984).. 18-135

Technological Experiments

Listed Primarily Chronologically,
but with Investigative Series of Principal Investigators Intact

Page

Heat Pipes/Thermal Control of Experiments

Ollendorf, S.: Thermal Canister Experiment (TCE) (STS OFT-3, 1982) 18-139

Koch, H., et al.: Heat Pipe Experiment on SPAS (STS 31-C, 1983) 18-144

Rankin, J. G., et al.: Heat Pipe Radiator (STS 31-D, 1983) 18-149
Rankin, J. G.: Space Station Heat Pipe Advanced Radiator Element (STS-29, 1989) 18-153

Walden, V., et al.: Heat Pipe Fluid Flow Experiment (STS 41-B, 1984) 18-156
Walden, V., et al.: Heat Pipe Fluid Flow Experiment (STS 41-G, 1984) 18-159

Grote, M., et al.: Cascade Variable-Conductance Heat Pipe (STS 41-C, 1984/1990) 18-162

Owen, J. W., et al.: Transverse Heat Pipe Experiment (STS 41-C, 1984/1990) 18-166

McIntosh, R., et al.: Low Temperature Heat Pipe Experiment Package (STS 41-C, 1984/1990) 18-169
McIntosh, R., et al.: Capillary Pumped Loop (STS 51-D, 1985) 18-173
McIntosh, R., et al.: Capillary Pumped Loop (STS 51-G, 1985) 18-178
McIntosh, R.: Capillary Pump Loop Experiment (STS 61-C, 1986) 18-184

Monodisperse Latex Reactor

Vanderhoff, J. W., et al.: Monodisperse Latex Reactor (STS OFT-3, 1982) 18-189
Vanderhoff, J. W., et al.: Monodisperse Latex Reactor (STS OFT-4, 1982) 18-195
Vanderhoff, J. W., et al.: Monodisperse Latex Reactor (STS 31-B, 1983) 18-199

Technological Experiments

Listed Primarily Chronologically by Topic, but with Investigative Series of Principal Investigators Intact

Page

Monodisperse Latex Reactor, Cont.

Vanderhoff, J. W., et al.: Monodisperse Latex Reactor (STS 31-C, 1983).............................. 18-203
Vanderhoff, J. W., et al.: Monodisperse Latex Reactor (STS 41-B, 1984).............................. 18-207

Electroplating

Peter, L. J., et al.: Electroplating (STS 31-B, 1983).. 18-212

<Note: Other experiments related to electrodeposition can be found in Chapter 15: Physical Chemistry (see for example, Ehrhardt "Dispersion Electrolysis" or Riley "Electrodeposition of Cells").>

Tribology

Pan, C.H.T., et al.: Tribological Experiments in Zero Gravity (STS Spacelab 1, 1983).................. 18-215

Slip Casting

Schweitzer, K.: Slip Casting I (STS 41-B, 1984)....... 18-220
Schweitzer, K.: Slip Casting II (STS 51-G, 1985).... 18-224

Acceleration Measurement

Gadsden, M., et al.: Stability of Materials - Residual Acceleration Measurements (STS 41-B, 1984)... 18-228

Bijovet, J., et al.: Accelerometer Measurements On Board Consort 1 (Consort 1, 1989)................. 18-231

Technological Experiments

Listed Primarily Chronologically by Topic,
but with Investigative Series of Principal Investigators Intact

Page

In Orbit Refueling

<Note: The majority of the experiments in this data base related to in-orbit refueling can be found in the Fluid Physics Chapter (see for example, Abdalla (Apollo 14), Tegart (STS 51-C), etc.).

Griffin, J. W., et al.: An Orbital Refueling System (ORS) Flight Demonstration (STS 41-G, 1984)........... 18-234

Art

<Note: There are three experiments within the data base which were related to artistic as well as scientific initiatives. Two are listed below. The third can be found in Chapter 10: Crystal Growth From Vapor (see McShane, STS 41-G, "Art in Space: Coating of Glass Spheres by Vacuum Deposition Techniques.").

Sampling of Space Vacuum/Art

McShane, J. W., et al.: Art in Space: Sampling and Artistic Preservation of the Space Vacuum (STS 41-G, 1984).................................... 18-238

Reaction of Oil Paints on Canvas/Art

Wishnow, H., et al.: Reaction of Oil Paints on Canvas to Space Travel (STS 61-C, 1986)............... 18-241

Operation of Liquid Laser

Casarez, C., et al.: Testing of a Liquid Laser (STS 51-G, 1985).................................... 18-244

Technological Experiments

Listed Primarily Chronologically by Topic,
but with Investigative Series of Principal Investigators Intact

Page

Performance of Computer Chips

Thurston, J., et al.: Performance of Dynamic Random Access Memory (DRAM) Chip in Space Environment (STS 51-G (planned)) 18-247

High Performance Liquid Chromatography

Alltech Associates, Inc., et al.: High Performance Liquid Chromatography (STS 61-C, 1986) 18-250

Paper Formation

Hebert, D. J., et al.: Formation of Paper (STS 61-C, 1986) 18-252

Section 3: Indexes

Index A: Key Words

Key Words Index

<Note: These Key Words identify aspects of the experiments specifically discussed in post-flight reports, often employing the nomenclature of the reports.>

A

Absence of Buoyancy Forces (Detrimental) 8-27, 9-76, 9-138, 10-28, 18-12, 18-22, 18-25, 18-105

Absence of Convection see "Buoyancy Effects," "Buoyancy Effects Diminished," "Buoyancy Forces," "Buoyancy-Driven Convection," "Convection," and "Marangoni Convection Diminished"

Acceleration Effects (see also "Launch-Induced Fluid Motion," "Rocket Motion," "Rocket Vibration," "Processing at High Gravity Levels," and "Vehicle Re-Entry Forces/Vibrations") 1-101, 1-111, 1-121, 2-19, 2-33, 2-62, 4-16, 4-24, 4-51, 5-18, 5-33, 5-39, 5-48, 5-57, 5-62, 5-90, 5-95, 5-99, 5-132, 6-8, 6-17, 6-28, 6-52, 7-8, 8-3, 8-48, 8-63, 8-67, 8-74, 8-99, 9-41, 9-57, 9-69, 9-73, 9-95, 9-104, 9-129, 9-144, 9-149, 9-153, 11-48, 11-50, 11-52, 11-74, 11-89, 12-3, 12-7, 12-13, 12-18, 12-56, 12-60, 12-65, 12-71, 12-74, 12-79, 12-82, 12-86, 12-90, 12-93, 12-105, 12-113, 12-118, 12-129, 12-139, 12-149, 12-157, 12-190, 12-209, 12-211, 12-213, 12-240, 12-252, 12-256, 12-264, 12-275, 12-301, 12-311, 12-316, 13-14, 13-16, 13-18, 14-26, 14-29, 14-32, 14-35, 14-42, 14-116, 14-120, 14-134, 14-150, 15-3, 15-22, 15-30, 15-57, 15-63, 15-72, 15-76, 16-3, 16-25, 16-31, 16-58, 16-70, 17-26, 17-34, 17-66, 17-82, 17-88, 17-105, 17-133, 17-163, 17-217, 17-222, 17-224, 17-226, 18-15, 18-71, 18-86, 18-125, 18-153, 18-199, 18-215, 18-228, 18-231, 18-241

Acceleration Measurements 8-74, 9-144, 12-157, 12-256, 12-275, 17-163, 18-215, 18-228, 18-231

Accelerations/Vibrations Produced by Onboard Equipment 11-74, 12-149, 15-3, 15-57, 18-231

Acoustic Levitation (see also "Electromagnetic Levitator") 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 12-50, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 18-64, 18-67, 18-71, 18-73

Acoustic Mixing (see also "Liquid Mixing" and "Ultrasonic Mixing") 17-142, 17-149, 17-181

Acoustic Positioning (see also "Standing Waves") 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 12-50, 12-96, 12-98, 12-103, 18-64, 18-67, 18-71, 18-73

Acoustic Streaming 6-35, 6-39

Adhesion of Metals (see also the "Metal..." titles) 14-120, 15-16, 18-15

Adiabatic Expansion 12-90, 12-93, 18-234

Air Fan 10-33, 17-159, 17-163, 18-199

Air Pressure see "Gas Pressure"

Alkaline Glasses (see also "Glasses" (this index); "glass" and "alkali silicate" in the Sample Materials Index) 11-13, 11-17, 11-21, 11-24, 11-33, 11-37, 11-44, 11-48, 11-50, 11-52

Alloys (see also "Dispersion Alloys," "Immiscible Alloys," "Metals and Alloys," "Rare Earth Alloys," "Binary Systems," "Ternary Systems," and the "Composites..." titles) 6-48, 6-52, 6-54, 9-19, 9-25, 9-57, 9-61, 9-63, 9-65, 9-67, 9-125, 11-62, 11-82, 12-71, 12-74, 13-11, 18-3, 18-8, 18-12, 18-15, 18-19, 18-67, 18-73, 18-77, 18-86, 18-89, 18-92, 18-99, 18-102, 18-111

Amorphous Materials 6-21, 6-48, 6-52, 6-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-121, 15-13, 15-81, 16-8, 16-10, 18-12, 18-19, 18-67

Annealing 8-88, 11-65, 11-70, 17-59

Anode (see also "Cathode" and "Electrodes") 8-55, 8-58, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-81, 18-212

Anomalies see "Contamination Source," "Deterioration of Loaded Samples Prior to Launch," "Deterioration of Samples After Low-G Flight," "Furnace Malfunction," "Fuse Blowout," "Gas Leakage," "Hardware Malfunction," "Illumination Difficulties," "Incomplete Sample Processing," "Launch-Induced Fluid Motion," "Liquid Leakage," "Non-Wetting of Container," "Oxidation," "Payload Recovery System Failure," "Payload Survivability," "Photographic Difficulties," "Processing Difficulties," "Processing Time Not As Long As Planned," "Material Interaction With Containment Facility," "Rocket Despin Failure," "Rocket Failure," "Rocket Vibration," "Sample Deformation," "Sample Detachment From Crucible," "Sample Evaporation," "Sample Necking," "Sample Not Processed As Planned," "Thermal Environment More Extreme Than Predicted," "Vehicle Re-Entry Forces/Vibration," and the "Acceleration..." and "Battery..." titles

Antibodies (see also "antibody" in the Sample Materials Index) 1-86, 1-90, 1-113, 16-25, 16-65

Antigen 1-86, 1-90

Aqueous Solutions (see also "Solutions") 1-22, 1-26, 1-29, 1-78, 1-95, 1-101, 1-161, 2-6, 2-9, 2-13, 2-26, 2-65, 7-17, 7-21, 8-7, 8-12, 8-17, 8-48, 8-55, 8-58, 8-81, 8-95, 9-39, 9-45, 9-48, 11-3, 11-7, 11-95, 12-194, 12-198, 12-201, 12-206, 12-301, 12-307, 12-311, 12-316, 12-321, 14-19, 14-23, 14-26, 15-22, 15-24, 17-226, 18-252

Arc Behavior (Metal Halide Arc Behavior) 18-131

Arc Welding (see also "Welding") 4-19

Art 10-46, 18-238, 18-241

Aspect Ratio (see also "Container Shape" and "Crucible Effects") 1-26, 1-101, 2-16, 12-74, 12-98, 12-135, 12-149, 12-217, 17-51

Asymmetric Temperature Field (see also "Thermal Gradient") 8-88, 9-14, 9-27, 12-190, 18-77

Atmospheric Applications (see also "Rotating Atmospheres") 12-42, 12-46, 12-260

Autoclave 7-17, 7-21

Axial Oscillations (see also "Oscillation") 2-33, 2-41, 12-30

Axial Segregation (see also "Segregation") 9-34, 9-101, 9-106, 9-109, 9-144

B

Baffles (see also "Capillary Flow," "Capillary Forces," "Fluid Management," and "Sloshing") 7-17, 7-21, 12-3, 12-7, 12-13, 12-18, 12-252, 12-256, 16-22, 18-178

Battery Drain 2-46, 8-58, 17-159, 18-56, 18-59

Battery Failure 18-173

Battery Leakage 17-159

Battery Short 8-81, 18-244

Battery Voltage Too Low 18-58

Beads see "beads" in the Sample Materials Index

Bearings 18-215

Bénard Cells 12-13, 12-18

Bénard Convection (see also "Convection") 12-13, 12-18, 12-184

Binary Systems (see also "Alloys" and "Composites") 4-9, 4-13, 4-16, 4-19, 4-24, 4-27, 4-29, 4-47, 4-51, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-76, 5-79, 5-82, 5-85, 5-87, 5-95, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-3, 6-8, 6-13, 6-17, 6-25, 6-35, 6-39, 6-57, 7-3, 7-5, 7-8, 7-11, 7-17, 7-21, 7-24, 7-27, 7-31, 7-33, 7-36, 8-7, 8-12, 8-17, 8-38, 8-52, 8-88, 8-92, 9-5, 9-9, 9-14, 9-27, 9-51, 9-54, 9-69, 9-73, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 9-95, 9-98, 9-101, 9-106, 9-109, 9-112, 9-117, 9-121, 9-125, 9-134, 9-149, 9-153, 9-156, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-65, 10-68, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-55, 11-58, 11-62, 11-65, 11-70, 11-74, 11-79, 11-82, 11-86, 12-56, 12-71, 12-74, 12-139, 12-144, 12-149, 12-153, 12-157, 12-167, 12-172, 13-3, 13-21, 14-8, 14-11, 14-19, 14-23, 14-

26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-57, 14-59, 14-61, 14-65, 14-69, 14-73, 14-76, 14-80, 14-82, 14-85, 14-89, 14-93, 14-105, 14-109, 14-112, 14-114, 14-124, 14-126, 14-128, 14-131, 14-134, 14-145, 14-148, 14-150, 14-153, 14-159, 14-163, 15-66, 15-69, 17-6, 17-11, 17-14, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-90, 17-92, 17-95, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-146, 17-149, 17-152, 17-155, 17-159, 17-163, 17-169, 17-172, 17-178, 17-181, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-217, 17-226, 18-3, 18-15, 18-64, 18-86, 18-89, 18-92, 18-108

Bioceramics (see also "Ceramics") 11-33

Biological Cells (see also "Lymphokines," "White Cells," and the "Cell..." titles (this index) and "cell" in the Sample Materials Index) 1-3, 1-10, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-86, 1-90, 1-95, 1-101, 1-105, 1-108, 1-111, 1-113, 1-118, 1-121, 1-125, 1-128

Biological Materials Processing 1-29, 1-152, 16-5, 16-8, 16-10, 16-12, 16-15, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65

Biological Structures (see also "Structure") 1-135, 1-152, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65

Biotechnology(see also "Medical Applications") 1-3, 1-6, 1-10, 1-14, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-86, 1-90, 1-95, 1-101, 1-105, 1-108, 1-111, 1-113, 1-118, 1-121, 1-125, 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 8-99, 12-280, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65, 17-226

Birefringence 8-12, 9-19, 9-25

Blood Cells see "Biological Cells"

Blood Clotting 1-29, 1-73, 1-152, 2-6, 16-65

Boiling (see also "Bubble Nucleation" and "Nucleate Pool Boiling") 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 17-102

Bone Marrow Transplants see "Human Bone Marrow Transplants"

Boundary Layer (see also "Diffusion Boundary") 8-3, 9-112, 11-86, 12-217, 12-237, 14-137, 14-141, 18-111

Brazing 18-3, 18-8, 18-12, 18-15

Bridgman Technique (see also "Directional Solidification," "Semi-Confined Bridgman Growth," and "Solidification") 9-95, 9-109, 9-156, 14-163, 17-26, 17-30, 17-133, 17-136, 17-175

Brittleness 6-17, 14-15, 17-22

Brownian Motion (see also "Particle Motion") 4-47, 8-105, 13-11, 15-3, 15-57, 15-78

Bubble Agglomeration see "Particle Agglomeration"

Bubble Centering 12-90, 12-93

Bubble Coalescence (see also "Particle Coalescence") 2-26, 4-32, 4-35, 4-41, 5-121, 6-35, 12-60, 12-65, 12-167, 13-11, 15-24

Bubble Dispersion (see also "Dispersion" and "Particle Dispersion") 2-6, 2-9, 2-26, 4-3, 4-9, 4-13, 4-16, 4-19, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 4-57, 5-7, 5-10, 12-65, 13-11, 14-116

Bubble Distribution (see also "Particle Distribution") 4-35, 9-39

Bubble Dynamics (see also "Bubble Motion," "Bubble Stability," and "Hydrodynamics") 12-90, 12-93, 12-103, 12-289, 15-41, 15-49

Bubble Formation (see also "Gas Formation") 2-26, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-32, 4-35, 4-38, 4-41, 4-44, 4-51, 5-57, 5-121, 5-124, 5-126, 5-140, 8-30, 8-45, 9-19, 9-39, 9-41, 9-156, 11-13, 12-7, 12-27, 12-38, 12-65, 12-90, 12-93, 12-103, 12-135, 12-167, 12-175, 12-217, 12-233, 12-280, 12-289, 12-307, 12-316, 12-321, 13-11, 14-89, 14-116, 15-10, 15-13, 15-22, 15-24, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 15-53, 16-22, 17-56, 17-120, 18-189, 18-203, 18-224

Bubble Growth (see also "Particle Growth") 4-19, 4-51, 6-44, 12-60, 12-65, 13-11, 14-116, 15-24, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49

Bubble Injection (see also "Gas Injection" and "Liquid Injection") 4-55, 12-289

Bubble Migration (see also "Bubble Motion," "Bubble Transport," "Marangoni Movement (Migration) of Bubbles," "Particle Migration," and "Thermomigration") 12-60, 12-65, 12-103, 12-167, 12-217, 12-289, 12-294

Bubble Motion (see also "Bubble Migration" and "Bubble Dynamics") 4-47, 6-39, 12-60, 12-65, 12-90, 12-93, 12-289, 12-294, 14-116

Bubble Nucleation (see also "Boiling" and "Nucleation") 2-3, 4-32, 4-51, 12-60, 12-65, 13-11, 15-24, 15-32, 15-41, 15-44, 15-49

Bubble Removal 12-175, 12-256, 12-289, 15-5, 16-3, 17-14, 17-56, 17-63, 17-69, 17-72

Bubble Rotation (see also "Rotating Fluids" and "Sample Rotation") 12-93

Bubbles 1-6, 1-10, 1-17, 2-6, 2-9, 2-26, 5-3, 5-7, 5-10, 5-29, 5-57, 5-121, 5-124, 5-126, 5-140, 6-28, 6-35, 6-39, 6-44, 7-24, 7-27, 8-30, 8-45, 8-48, 9-19, 9-25, 9-39, 9-41, 9-48, 9-156, 11-3, 11-7, 11-13, 11-28, 12-24, 12-27, 12-38, 12-60, 12-90, 12-93, 12-103, 12-135, 12-167, 12-175, 12-217, 12-233, 12-252, 12-256, 12-275, 12-280, 12-289, 12-294, 12-307, 12-316, 12-321, 13-11, 14-89, 14-116, 15-5, 15-10, 15-13, 15-22, 15-24, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 16-5, 16-22, 17-199, 18-12, 18-105, 18-199, 18-203, 18-224

Bubble Sedimentation (see also "Sedimentation") 4-57

Bubble Shrinkage 6-44, 11-28

Bubble Stability (see also "Bubble Dynamics," "Foam Stability," and "Fluid Stability") 5-121, 12-90, 12-93, 12-103, 12-307, 12-321

Bubble Transport (see also "Bubble Migration," "Marangoni Movement (Migration) of Bubbles," and "Particle Migration") 12-167, 12-280, 12-289, 12-294

Buffer see "buffer" in the Sample Materials Index

Buoyancy-Driven Convection (see also "Convection" and "Thermal Convection") 1-95, 5-99, 5-104, 5-106, 6-8, 6-13, 6-17, 6-25, 7-5, 7-8, 7-11, 7-24, 7-27, 7-33, 7-36, 8-3, 8-7, 8-12, 8-17, 8-27, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-58, 8-63, 8-67, 8-74, 8-84, 8-88, 8-99, 8-105, 9-19, 9-25, 9-27, 9-31, 9-34, 9-51, 9-54, 9-73, 9-76, 9-98, 9-125, 9-129, 9-144, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 11-3, 11-7, 11-9, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-58, 11-62, 11-65, 11-70, 11-74, 11-91, 11-95, 12-13, 12-18, 12-260, 14-8, 14-11, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-46, 14-49, 14-52, 14-61, 14-65, 14-85, 14-89, 14-93, 14-97, 14-100, 14-112, 14-116, 14-124, 14-126, 14-128, 14-131, 14-134, 14-137, 15-5, 15-10, 15-13, 15-16, 15-19, 15-44, 15-53, 15-60, 15-63, 15-66, 15-69, 15-72, 15-81, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-63, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-116, 17-133, 17-136, 17-146, 17-155, 17-175, 18-131, 18-135

Buoyancy Effects 1-101, 4-27, 4-29, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 4-57, 5-18, 5-41, 5-45, 5-90, 5-95, 12-280, 14-137, 14-159, 15-22, 15-24, 15-32, 15-36, 15-41, 15-44, 15-49, 17-6, 17-22, 17-26, 17-30, 17-59, 17-63, 17-66, 17-69, 17-72, 17-82, 17-95, 17-120, 17-125, 17-128, 17-142, 17-146, 17-149, 17-152, 17-159, 17-163, 17-169, 17-172

Buoyancy Effects Diminished (see also "Absence of Buoyancy Forces (Detrimental)" and "Absence of Convection") 1-95, 1-140, 1-144, 1-148, 2-65, 4-9, 4-13, 6-13, 7-24, 8-24, 8-67, 9-27, 9-31, 9-48, 9-54, 9-81, 9-117, 9-121, 9-129, 9-134, 9-138, 9-149, 9-153, 11-9, 11-13, 11-17, 11-21, 11-28, 11-65, 11-82, 12-13, 12-18, 12-65, 12-109, 12-144, 12-149, 12-167, 12-175, 12-184, 12-194, 12-201, 12-284, 12-289, 12-294, 12-311, 13-11, 13-21, 14-3, 14-11, 14-23, 14-29, 14-38, 14-46, 14-49, 14-52, 14-100, 14-153, 14-159, 15-5, 15-10, 15-26, 16-65, 17-14, 17-22, 17-26, 17-30, 17-120, 17-136, 18-77, 18-131, 18-189, 18-195, 18-199, 18-203, 18-207

Buoyancy Forces (see also "Absence of Buoyancy Forces (Detrimental)" 5-10, 5-140, 14-61, 15-44, 15-49, 17-43, 18-252

Burn Rates 3-3

C

Calorimetric Measurements 7-11, 9-134, 14-69, 14-73

Cantilevered Spring Beam 18-61

Capillaries 2-16, 5-140, 7-33, 11-33, 11-37, 11-65

Capillarity 2-3, 2-6, 2-9, 2-13, 2-16, 2-19, 2-21, 2-24, 2-26, 2-28, 2-33, 2-37, 2-41, 2-46, 2-49, 2-52, 2-54, 2-58, 2-62, 2-65

Capillary Flow (see also "Baffles," "Fluid Management," and the "Thermocapillary..." titles) 1-161, 2-3, 2-13, 2-16, 2-19, 2-21, 2-24, 2-62, 2-65, 5-48, 5-95, 8-99, 12-7, 12-144, 12-252, 17-34, 17-38, 17-43, 17-139, 18-3, 18-8, 18-12, 18-19, 18-82, 18-139, 18-144, 18-149, 18-153, 18-156, 18-162, 18-169, 18-173, 18-178, 18-184, 18-215

Capillary Forces 2-3, 2-13, 2-16, 2-19, 2-21, 2-24, 2-37, 2-41, 4-27, 4-29, 4-32, 4-35, 5-14, 5-95, 8-99, 12-7, 12-30, 12-175, 12-178, 12-181, 12-243, 12-252, 12-256, 13-3, 13-6, 17-139, 17-199, 17-205, 17-217, 18-8, 18-12, 18-15, 18-19, 18-102, 18-139, 18-144, 18-149, 18-153, 18-156, 18-159, 18-162, 18-169, 18-173, 18-178, 18-184, 18-215, 18-224

Capillary Pressure 2-37, 2-41

Capillary Rise 2-3, 2-16, 2-21, 2-24

Capillary Tubes 2-3, 2-16, 2-19, 2-21, 2-24, 12-7

Capillary Waves 2-46, 2-49, 12-46

Casting (see also "Skin Casting," "Slip Casting," and "Skin Technology") 1-165, 1-170, 4-55, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-48, 5-52, 6-17, 9-41, 9-48, 14-3, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-100, 17-56, 18-220

Catalysts 4-57, 15-53, 15-81, 17-230

Cataphoresis 18-131

Cathode (see also "Anode" and "Electrodes" (this index) and "plated cathode" in the Sample Materials Index) 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-81, 18-212

Cavity (see also "Open Cavity") 4-51, 5-48, 8-3, 9-5, 9-9, 9-156, 13-11, 14-32, 14-35, 14-42, 14-100, 14-153, 17-43, 18-82, 18-89, 18-111

Cell Attachment 1-78

Cell Differentiation 1-86, 1-90

Cell Fusion (see also "Electrofusion") 1-105, 1-108, 1-111, 1-113, 1-118, 1-125

Cells (Biological) see "Biological Cells"

Cells (Blood) see "Biological Cells"

Cell Secretion 1-128

Cell Separation see "Electrophoresis," "Phase Partitioning," "Particle Separation," "Phase Separation," and "Separation of Components"

Cell Storage 1-78, 1-86, 1-90, 1-113, 1-118, 1-121, 1-128

Cell Survivability 1-90, 1-118, 1-121

Cellular Characteristics 1-128, 5-126

Cellular Convection 12-13, 12-18, 12-184, 12-194, 12-198, 12-201, 12-284, 12-307, 12-321

Cellular Morphology 4-3, 4-9, 4-16, 4-19, 4-47, 6-3, 9-125, 14-159, 17-75, 18-111

Centrifuge (see also "Processing at High Gravity Levels" and "Rotating Fluids") 1-90, 8-7, 14-29, 14-32, 14-42, 14-134, 17-14

Ceramics (see also "Bioceramics" (this index), "ceramic" in the Sample Materials Index, and "ceramic film" in the Container Materials Index) 5-99, 5-104, 5-106, 11-40, 14-145, 14-148, 14-159, 18-15, 18-89, 18-99, 18-102, 18-116, 18-220, 18-224

Chameleon Skin 1-128

Charged Particles (see also "Electrophoresis" and "Surface Charge") 8-105

Chemical Oscillations (see also "Oscillation") 12-280

Chemical Vapor Transport (see also "Crystal Growth From Vapor," "Diffusion-Controlled Growth," and "Vapor Deposition") 10-7, 10-12, 10-16, 10-68

Chemical Waves 12-280

Chromatography see "High Performance Liquid Chromatography"

Closed Cell Foam (see also "Foams") 4-9, 4-13

Clouds 12-42

Coagulation 1-14, 4-19, 5-10, 5-99, 5-104, 5-121, 5-140, 15-13, 15-16, 15-19, 15-76, 15-78, 15-81, 17-142, 17-149, 17-152, 17-163, 17-183, 17-196, 17-222, 17-224, 18-189, 18-207

Coarsening (see also "Particle Coarsening") 4-13, 13-21, 14-100, 17-69, 17-75, 17-163

Coated Fibers (see also the "Fiber..." titles (this index) and "coated materials" in the Sample Materials Index) 5-10, 5-113

Coated Float Zones (see also "Encapsulated Float Zones" and "Float Zones" (this index) and "coated materials" in the Sample Materials Index) 9-91, 9-101, 9-106, 9-109, 9-112, 9-117, 9-121, 9-138, 9-156

Coated Particles (see also "coated materials" in the Sample Materials Index) 5-3, 5-7, 5-10, 13-3

Coated Surfaces (see also (1) in this index: "Hydrophobic Surfaces," "Plasma Spray Coating," "Wetting," Non-wetting of Container," and the "Film..." and "Skin..." titles, (2) "coated materials" in the Sample Materials Index, and (3) "coated materials," "coating," "film," "plasma-spray," "skin," and "wettability" in the Container Materials Index) 1-10, 1-22, 1-29, 1-101, 2-16, 2-24, 2-37, 2-41, 2-46, 2-49, 3-3, 4-13, 4-24, 4-47, 5-3, 5-33, 5-35, 5-76, 5-79, 5-109, 6-32, 6-57, 8-3, 8-24, 8-30, 8-63, 8-67, 8-88, 9-9, 9-19, 9-25, 9-27, 9-31, 9-84, 9-101, 9-106, 9-109, 9-117, 9-121, 9-138, 9-156, 10-46, 10-72, 11-37, 11-58, 11-65, 12-30, 12-45, 12-53, 12-56, 12-105, 12-109, 12-139, 12-144, 12-149, 12-153, 12-162, 12-178, 12-194, 12-217, 12-222, 12-264, 12-280, 12-284, 12-307, 13-3, 13-6, 14-97, 14-100, 14-159, 14-167, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-41, 15-44, 15-49, 15-81, 16-31, 16-37, 16-42, 17-69, 17-142, 17-149, 17-181, 17-226, 18-31, 18-34, 18-37, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123, 18-139, 18-212, 18-215, 18-241

Codeposition (see also "Deposition") 15-10, 15-13, 15-16, 15-19, 15-81

Coercive Strength 17-120, 17-125

Collagen Structures (see also "Structure") 1-135

Collision of Metals 14-120

Collisions (see also "Droplet Collision," "Impact Velocity," and "Solid/Liquid Collision") 5-118, 5-135, 6-3, 6-17, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-54, 6-57, 12-86, 12-289, 15-3, 18-189, 18-199, 18-203, 18-207

Colloidal Chemistry 1-14, 15-3, 15-76, 15-78

Columnar Solidification (see also "Solidification") 14-19, 14-23, 14-26, 14-46

Columnar to Equiaxed Transition (see also "Equiaxial Zone") 9-41, 9-48, 14-19, 14-23, 14-65

Combustion Studies 3-3

Composites see below and also "Alloys," "Binary Systems," "High Stiffness Composites," "Magnetic Composites," and "Ternary Systems"

Composites with Gases (see also "Dispersion Alloys," "Foams," "Gas Formation," "Immiscible Alloys," "Metallic Matrix," and "Minority Phase") 4-3, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-47, 4-51, 4-57, 5-3, 5-7, 5-10, 5-90, 5-121, 5-124, 5-126, 5-140, 12-60, 12-65, 13-11

Composites with Solid Particles (see also see also "Dispersion Alloys," "Immiscible Alloys," "Metallic Matrix," "Minority Phase" and the "Particle..." titles) 4-27, 4-29, 4-47, 4-55, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-99, 5-104, 5-106, 5-109, 5-113, 5-116, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-17, 13-3, 13-6, 13-11, 13-18, 13-21

Composition see the "Composition..." titles (below), "Decomposition," Hypermonotectic Compositions," "Monotectic Compositions," and "Spinodal Decomposition"

Composition Distribution (see also "Concentration Distribution," "Density Difference," and "Solutal Gradients") 6-3, 7-24, 7-27, 9-144, 11-40, 11-65, 11-70, 11-79, 14-61, 14-85, 14-109, 14-128, 14-131, 14-134, 15-53, 17-18, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-187

Composition Gradients see "Solutal Gradients"

Composition Variation 9-19, 9-25, 9-69, 9-73, 9-76, 9-91, 9-144

Compressible Solutions (see also "Solutions") 7-17, 7-21

Compressive Heating 18-234

Computer Chip Performance 18-247

Computer Data Storage 18-247

Concentration Distribution (see also "Composition Distribution," "Gas Concentration," and "Solutal Gradients") 1-29, 1-135, 6-13, 8-7, 8-88, 8-95, 9-112, 9-117, 9-121, 9-125, 11-9, 11-13, 11-21, 11-24, 11-28, 11-55, 11-58, 11-62, 11-82, 11-86, 12-105, 12-109, 12-307, 12-321, 14-35, 14-137, 14-159, 15-10, 16-63

Condensation 5-48, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-68, 12-79, 12-256, 13-21, 15-32, 15-36, 15-41, 15-44, 15-49, 18-139, 18-144, 18-149, 18-153, 18-159, 18-173, 18-178, 18-184

Condensers 18-139, 18-144, 18-149, 18-153, 18-173, 18-178, 18-184

Conductance (see also "Linear Conductors") 7-17, 7-21, 8-58, 14-15

Conduction (see also "Heat Conduction," "Linear Conductors," "Semiconductors," and "Superconductors") 12-243, 12-289, 12-294, 12-311, 12-316, 15-5, 15-22, 15-24, 15-26, 15-32, 15-36, 15-60, 15-66, 15-69, 17-205

Conductivity see "Electrical Conductivity," "Semiconductors," "Superconductivity," "Superconductors," and "Thermal Conductivity Measurements"

Consulate Temperature 11-79

Contact Angle 1-95, 1-101, 2-13, 2-21, 2-28, 2-37, 2-41, 2-58, 5-90, 5-95, 5-99, 9-84, 9-156, 12-7, 12-30, 12-53, 12-105, 12-109, 12-139, 12-144, 12-149, 12-153, 12-162, 12-175, 12-178, 12-181, 12-229, 12-233, 17-59, 17-63, 17-205, 17-217, 18-12, 18-15, 18-102, 18-108, 18-116

Contained Fluids (see also "Containers," "Liquid Reservoir," "Material Interaction with Containment Facility," "Solid/Liquid Interface," "Vapor/Solid Interface," and "Wetting of Container") 1-3, 1-6, 1-10, 1-14, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-95, 1-101, 1-105, 1-108, 1-111, 1-113, 1-118, 1-121, 1-125, 1-128, 1-135, 1-152, 1-157, 1-161, 2-6, 2-9, 2-26, 2-46, 2-49, 2-65, 4-47, 7-17, 7-21, 7-24, 7-27, 7-33, 7-36, 8-3, 8-7, 8-12, 8-17, 8-27, 8-30, 8-34, 8-48, 8-55, 8-58, 8-63, 8-67, 8-74, 8-95, 8-99, 12-3, 12-7, 12-13, 12-18, 12-22, 12-24, 12-38, 12-42, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-213, 12-229, 12-233, 12-252, 12-256, 12-260, 12-264, 12-271, 12-275, 12-280, 12-284, 12-289, 12-294, 12-301, 12-305, 12-307, 12-311, 12-316, 12-321, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-32, 15-36, 15-41, 15-44, 15-49, 15-60, 15-72, 15-78, 15-81, 16-3, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-63, 16-70, 17-155, 17-178, 17-199, 17-226, 18-189, 18-195, 18-199, 18-203, 18-207, 18-212, 18-234, 18-252

Container Effects see "Crucible Effects"

Containerless Melt (see also "Crystal Growth from the Melt" and "Semi-Containerless Melt") 6-17, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 14-69, 15-5

Containerless Processing (see also other "Containerless..." titles and "Semi-Containerless Melt") 6-3, 6-8, 6-13, 6-17, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 9-39, 9-149, 9-153, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 18-64, 18-71, 18-73

Containerless Processing Applications 2-28, 2-33, 2-52, 2-54, 2-58, 9-84, 9-88, 12-30, 12-50, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-187, 12-190, 12-206, 12-217, 12-222, 12-226, 12-237, 12-243, 15-5, 17-205

Containers see "Contained Fluids," "Liquid Reservoir," "Material Interaction with Containment Facility," "Non-Wetting of Container," "Partially Filled Containers," "Sample Detachment from Crucible," "Spinning Containers," and "Wetting of Container"

Container Shape (see also "Aspect Ratio" and "Crucible Effects") 1-26, 1-101, 2-6, 2-16, 2-19, 2-21, 2-24, 5-57, 6-8, 6-13, 9-134, 12-229, 12-233, 12-301, 17-226

Contamination Source (see also "Impurities," "Liquid Leakage," and "Sample Purity") 1-57, 1-69, 1-73, 1-83, 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-16, 2-65, 6-8, 6-28, 6-32, 6-54, 6-57, 8-7, 8-27, 8-81, 8-95, 8-99, 8-105, 9-9, 9-19, 9-25, 9-34, 9-41, 9-84, 9-95, 9-112, 9-138, 10-72, 11-91, 11-95, 12-60, 12-65, 12-79, 12-162, 12-284, 12-311, 14-69, 15-13, 16-65, 16-70, 17-113, 17-205, 18-73, 18-244

Continuous Flow Electrophoresis (see also "Electrophoresis") 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83

Convection (see also "Bénard Convection," "Buoyancy-Driven Convection," "Convection at the Interface," "Gaseous Convection," "Liquid Mixing," "Marangoni Convection", "Steady to Oscillatory Convective Transition," "Surface Tension-Driven Convection," "Thermal Convection," "Thermocapillary Convection," "Thermosolutal Convection," and "Time Dependent Thermocapillary Flow") 1-3, 1-6, 1-22, 1-26, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-125, 1-135, 1-140, 1-144, 1-148, 1-152, 1-165, 1-170, 2-21, 3-3, 4-3, 4-51, 5-57, 5-118, 5-121, 5-126, 5-140, 6-57, 8-67, 9-79, 9-129, 11-82, 11-86, 12-42, 12-71, 12-74, 14-3, 14-57, 14-82, 15-5, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 18-19, 18-77, 18-149, 18-153

Convection at the Interface (see also "Convection," "Surface Tension-Driven Convection," and the "Interface..." titles) 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-126, 15-32, 15-36, 15-41, 15-49

Cooled Sting Technique 8-27, 8-74

Cooling see "Passive Cooling," "Radiative Cooling," "Solidification Rate," "Supercooling," and "Undercooling")

Cooling Rate (see also "Growth Rate," "Pulling Rate," "Solidification Rate," and "Translation Rate") 6-21, 7-5, 7-36, 9-5, 9-19, 9-25, 9-31, 9-34, 9-48, 9-69, 11-40, 14-29, 14-32, 14-35, 14-42, 14-65, 14-69, 14-73, 17-38, 17-43, 17-51, 17-56, 17-113, 17-120, 17-125, 17-128, 17-205

Coriolis Forces 12-260

Corrosion (see also "Electrochemical Corrosion") 7-17, 7-21, 11-17, 11-24, 15-10, 15-13, 15-16, 15-19, 15-26

Cosmic Rays 1-90, 18-247

Cracks 8-24, 8-52, 8-99, 9-19, 9-25, 12-167, 15-10

Critical Density 7-5, 7-8, 7-11, 7-24, 7-33, 7-36

Critical Marangoni Number (see also "Marangoni Convection") 12-139, 12-144, 12-149, 12-153, 12-157, 12-190, 12-222, 12-237, 12-284

Critical Point Phenomena 7-3, 7-5, 7-8, 7-11, 7-17, 7-21, 7-24, 7-27, 7-31, 7-33, 7-36

Critical Velocity 14-116

Crucible Effects (see also "Aspect Ratio," "Container Shape," "Material Interaction with Containment Facility," "Sample Detachment from Crucible," "Non-Wetting of Container" and "Wetting of Container") 1-101, 2-6, 5-18, 5-48, 5-82, 5-140, 6-21, 6-48, 8-12, 8-34, 8-84, 8-99, 9-5, 9-27, 9-31, 9-34, 9-134, 10-38, 11-40, 11-65, 14-52, 14-69, 14-73, 14-89, 14-105, 14-153, 14-159, 14-163, 16-12, 17-38, 17-48, 17-51, 17-63, 17-69, 17-72, 17-75, 17-82, 17-92, 17-210, 17-226, 18-82

Crucible Shape see "Container Shape"

Cryogens 12-271, 12-275, 18-169

Crystal in addition to the "Crystal..." titles below, see "Inorganic Crystallization," "Insoluble Crystals," "Organic Crystals," "Microcrystalline Dispersion," "Protein Crystal Growth," "Salt Crystals," "Seed Crystals," "Single Crystals," "Snow Crystals," "Spherical Crystals," and "Three-Dimensional Crystalline Structure"

Crystal Growth From Solution (see also "Diffusion-Controlled Growth") 8-3, 8-7, 8-12, 8-17, 8-22, 8-24, 8-27, 8-30, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-55, 8-58, 8-63, 8-67, 8-74, 8-81, 8-84, 8-88, 8-92, 8-95, 8-99, 8-105, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65

Crystal Growth From the Melt (see also "Containerless Melt," "Diffusion-Controlled Growth," "Melt and Solidification," "Semi-Containerless Melt," and "Solidification") 9-3, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-39, 9-41, 9-45, 9-48, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 9-95, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-125, 9-129, 9-134, 9-138, 9-144, 9-149, 9-153, 9-156

Crystal Growth From Vapor (see also "Chemical Vapor Transport," "Deposition," "Diffusion-Controlled Growth," "Physical Vapor Transport," "Vapor Deposition," and "Vapor Diffusion Method") 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-65, 10-68, 10-72

Crystal Homogeneity (see also "Homogeneity" and "Sample Homogeneity") 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 8-92, 9-144, 9-149, 9-153, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-57, 10-62, 10-65

Crystalline Defects (see also the "Defect..." titles) 8-3, 8-7, 8-27, 8-34, 8-52, 8-58, 8-63, 8-67, 8-74, 8-88, 8-95, 8-105, 9-129, 9-149, 10-3

Crystalline Strain (see also "Strain") 10-16, 10-51

Crystalline Structure (see also "Structure") 5-76, 6-44, 8-3, 8-7, 8-12, 8-17, 8-22, 8-24, 8-30, 8-48, 9-112, 9-129, 9-138, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 11-40, 14-8, 14-11, 15-53, 15-81, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-42, 16-48, 16-53, 16-58, 16-63

Crystal Morphology (see also "Surface Morphology") 4-24, 6-8, 8-7, 8-12, 8-17, 8-22, 8-24, 8-27, 8-30, 8-38, 8-42, 8-45, 8-48, 8-52, 8-63, 8-67, 8-74, 8-81, 8-84, 8-88, 8-92, 8-95, 8-105, 10-7, 10-12, 10-16, 10-20, 10-24, 10-33, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-42, 16-48, 16-53, 16-58, 16-63

Crystal Shattering (see also "Payload Survivability") 16-70

Crystal Showers 16-53

Curing 5-109, 17-230

D

Debye-Sears-Effect 15-63, 15-66, 15-69

Decomposition (see also "Composition" and "Spinodal Decomposition") 15-53, 16-18

Defect Density (see also "Crystalline Defects") 8-3, 8-52, 8-88, 9-19, 9-25, 9-27, 9-31, 10-51, 10-65, 14-8, 14-11

Defects 5-35, 9-27, 9-31, 17-128, 18-3

Defect Spacing (see also "Crystalline Defects" and "Spacing") 14-8, 14-11

Dendrites 4-51, 5-35, 5-135, 6-3, 6-57, 8-7, 10-7, 11-86, 14-3, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-55, 14-100, 14-163, 17-43, 18-12

Dendritic Arm Spacing (see also "Spacing") 4-51, 5-35, 6-57, 11-86, 14-29, 14-35, 14-46, 14-61, 14-65, 14-93

Dendritic Solidification (see also "Interdendritic Fluid Flow" and "Solidification") 4-16, 4-19, 6-3, 6-57, 8-7, 10-7, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-46, 14-49, 14-55, 14-57, 14-65, 14-93, 14-163

Dendritic Structure (see also "Structure") 4-16, 4-19, 4-51, 5-135, 8-7, 9-19, 9-25, 9-48, 9-125, 11-40, 11-86, 14-57, 14-100, 14-163, 16-48, 16-53, 17-51, 17-95, 18-3, 18-82

Density (Critical) see "Critical Density"

Density Decrease 4-24, 4-32, 4-35

Density (Defect) see "Defect Density"

Density Difference (see also "Composition Distribution," "Concentration Distribution," and "Solutal Gradients") 1-10, 1-17, 1-95, 4-9, 4-13, 5-3, 5-7, 5-10, 5-41, 5-45, 5-52, 5-90, 5-95, 5-113, 7-24, 7-27, 8-27, 8-63, 8-67, 8-74, 9-57, 9-67, 9-79, 9-81, 11-3, 11-7, 11-33, 11-74, 11-79, 11-82, 12-71, 12-74, 12-105, 12-109, 12-115, 12-123, 12-126, 13-6, 13-11, 13-21, 14-29, 14-35, 14-38, 14-42, 14-61, 14-93, 14-137, 15-10, 15-13, 15-16, 15-19, 17-3, 17-6, 17-11, 17-14, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-120, 17-125, 17-128, 17-155, 17-159, 17-163, 17-169, 17-172, 17-183, 17-187, 17-199, 17-210, 17-214, 17-222, 17-224, 17-226, 18-220, 18-252

Density Distribution 2-65, 7-33, 7-36, 8-30, 11-37, 15-63, 15-66, 15-69

Deposition see "Codeposition," "Crystal Growth from Vapor," "Electrocodeposition," "Electrodeposition," "Sputter Deposition," "Vacuum Film Deposition," and "Vapor Deposition"

Detectors see "Gamma Ray Detectors," "Infrared Detector Applications," and "X-Ray Detectors"

Deterioration of Loaded Samples Prior to Launch 1-113, 1-118, 8-48, 15-26, 17-205

Deterioration of Samples After Low-G Flight 1-10, 1-108, 1-118, 8-105, 10-51, 10-72, 11-65, 14-159, 16-25, 16-31

Dialysis 16-25, 16-31, 16-37, 16-42

Dielectrophoresis (see also "Electrophoresis") 1-105, 1-108, 1-113, 1-118, 1-125

Diffusion (see also "Diffusive Mass Transfer," "Double Diffusion," "Interdiffusion," "Liquid/Liquid Diffusion," "Mass Transfer," "Radioactive Tracer Diffusion," "Self-Diffusion," "Soret Diffusion," "Thermal Diffusion," and "Vapor Diffusion Method") 1-17, 3-3, 4-3, 4-47, 5-14, 8-7, 8-12, 8-17, 8-27, 8-30, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-58, 8-63, 8-67, 8-74, 8-84, 8-88, 8-92, 8-95, 8-99, 8-105, 9-5, 9-9, 9-54, 9-79, 9-81, 9-117, 9-121, 9-125, 9-129, 9-134, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 11-3, 11-7, 11-9, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 11-55, 11-58, 11-62, 11-65, 11-70, 11-74, 11-79, 11-82, 11-86, 11-89, 11-91, 11-95, 12-13, 12-18, 12-56, 12-71, 12-74, 12-113, 12-115, 12-118, 12-123, 12-126, 12-162, 13-11, 13-21, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-69, 14-73, 14-93, 14-97, 14-100, 14-134, 14-137, 14-141, 14-159, 15-3, 15-16, 15-53, 15-72, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65, 17-6, 17-11, 17-18, 17-26, 17-30, 17-38, 17-82, 17-128, 17-163, 18-3, 18-8, 18-12, 18-116, 18-162

Diffusion Boundary (see also "Boundary Layer") 11-3, 11-7, 11-55, 11-58, 11-86, 14-100

Diffusion Coefficient 4-47, 8-74, 11-3, 11-7, 11-9, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-44, 11-58, 11-62, 11-65, 11-70, 11-74, 11-82, 12-115, 14-97, 14-100, 17-18, 17-38, 17-196

Diffusion-Controlled Growth (see also "Chemical Vapor Transport," "Crystal Growth From Solution," "Crystal Growth from the Melt," "Crystal Growth from Vapor," "Physical Vapor Transport," and "Protein Crystal Growth") 6-25, 8-7, 8-12, 8-17, 8-27, 8-34, 8-48, 8-63, 8-67, 8-74, 8-95, 9-5, 9-9, 9-54, 9-101, 9-106, 9-117, 9-129, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-51, 10-57, 10-62, 10-65, 10-68, 11-91, 14-93, 14-159, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 17-26, 17-30, 17-82

Diffusive Mass Transfer (see also "Diffusion," "Heat and Mass Transfer," and "Mass Transfer") 5-14, 6-25, 7-5, 7-8, 7-11, 8-7, 8-12, 8-17, 8-27, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-58, 8-63, 8-67, 8-74, 8-84, 8-88, 8-95, 8-99, 8-105, 9-54, 9-117, 9-121, 9-125, 9-129, 9-134, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 11-3, 11-7, 11-9, 11-13, 11-17, 11-21, 11-24, 11-33, 11-37, 11-44, 11-55, 11-58, 11-79, 11-82, 11-86, 11-89, 11-95, 12-56, 12-71, 12-74, 14-93, 14-97, 14-159, 15-72, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65, 17-6, 17-163, 17-199

Direct Exposure to Space Environment (see also "Sampling of Space Vacuum" and "Space Vacuum") 6-3, 10-46, 10-72, 18-238

Directional Solidification (see also "Bridgman Technique" and "Solidification") 4-16, 4-19, 4-51, 5-35, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-118, 5-121, 5-126, 5-130, 5-132, 5-135, 5-140, 6-8, 6-13, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-41, 9-45, 9-48, 9-69, 9-73, 9-84, 9-88, 9-109, 9-125, 9-129, 9-134, 9-144, 9-156, 11-86, 12-60, 12-65, 14-8, 14-11, 14-23, 14-26, 14-35, 14-46, 14-59, 14-61, 14-65, 14-82, 14-85, 14-89, 14-93, 14-97, 14-100, 14-116, 14-128, 14-131, 14-134, 14-141, 14-159, 14-163, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-43, 17-72, 17-75, 17-80, 17-95, 17-99, 17-102, 17-105, 17-110, 17-116, 17-133, 17-136, 17-139, 17-142, 17-146, 17-152, 17-175, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116

Dislocations 6-8, 6-13, 8-48, 8-63, 9-95, 9-129

Dispersion (see also "Bubble Dispersion," "Dispersion Alloys," "Dispersion Layers," "Dispersion Strengthening," "Droplet Dispersion," "Fiber Dispersions," "Gettering Dispersion Mechanism," "Homogeneous Dispersion," "Liquid/Gas Dispersion," "Liquid/Liquid Dispersion," "Metallic Dispersion," "Microcrystalline Dispersion," "Monodisperse Latex Particles," "Particle Dispersion," "Solid/Gas Dispersion," "Solid/Liquid Dispersion," "Solid/Liquid/Gas Dispersion," "Stability of Dispersions, "Suspension," and "Two-Phase System") 1-14, 1-95, 1-101, 14-15, 14-42, 14-52, 14-116, 14-153, 17-3, 17-6, 17-11, 17-14, 17-18, 17-120, 17-125, 17-128, 17-133, 17-136, 17-146, 17-152, 17-155, 17-159, 17-163, 17-169, 17-175, 17-181, 17-199, 17-224

Dispersion Alloys (see also "Alloys," "Dispersion," "Composites with Solid Particles," "Composites with Gases" and "Systems Exhibiting a Miscibility Gap") 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-118, 5-121, 5-126, 5-130, 5-132, 5-135, 5-140, 14-153, 17-69, 17-72, 17-75, 17-80, 17-82, 17-90, 17-92, 17-159, 17-163, 17-169, 17-172, 17-210, 18-82, 18-105, 18-108, 18-121, 18-123

Dispersion Layers (see also "Dispersion") 15-10, 15-13, 15-16, 15-19, 15-81

Dispersion Strengthening (see also "Dispersion," "Material Strength," and "Particle Strengthening") 5-48, 5-52, 5-69, 5-99, 5-104, 5-106, 5-118, 5-130, 5-132, 5-135, 14-15, 14-116, 17-159, 17-163, 17-169, 17-172

Dissolution 5-14, 7-17, 10-3, 13-6, 13-11, 14-52, 14-69, 14-73, 15-3, 15-24, 16-31, 17-159, 17-163, 18-19, 18-116

Dopant 6-8, 6-13, 8-38, 8-42, 8-88, 9-3, 9-5, 9-9, 9-14, 9-34, 9-69, 9-73, 9-76, 9-84, 9-88, 9-91, 9-98, 9-101, 9-106, 9-109, 9-112, 9-117, 9-121, 9-134, 9-149, 9-153, 9-156, 10-3

Dopant Distribution (see also "Particle Distribution") 6-8, 6-13, 8-38, 8-42, 8-45, 9-14

Double Diffusion (see also "Diffusion," "Interdiffusion," "Liquid/Liquid Diffusion," and "Self-Diffusion") 8-12, 8-34, 8-48, 8-63, 8-67, 8-95, 8-99, 11-7, 11-13, 11-17, 11-24, 11-33, 11-37, 11-44, 11-52, 11-55, 11-58, 16-5, 16-8, 16-10, 16-12, 16-15, 16-63, 16-65

Double Replacement Reaction 8-95

Drop in addition to the "Drop..." titles below, see "Flotation of Drops," "Hanging Drop Method," "Marangoni Movement of Droplets," "Thermocapillary Droplet Motion," and the "Droplet..." and "Particle..." titles

Drop Coalescence (see also "Particle Coalescence") 1-101, 5-90, 12-42, 12-46, 12-50, 12-77, 12-86, 12-96, 12-213, 12-222, 17-14, 17-38, 17-43, 17-48, 17-51, 17-59, 17-69, 17-75, 17-90, 17-92, 17-107, 17-113, 17-139, 17-146, 17-163, 17-178, 17-199

Drop Dynamics (see also "Drop Oscillation," "Drop Stability," "Drop Vibration," "Hydrodynamics," and "Oscillation") 6-44, 12-46, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-213, 12-246, 12-249, 12-298

Drop Formation (see also "Droplet Creation Via a Syringe," "Liquid Expulsion Through a Small Orifice," and "Liquid Injection") 4-3, 12-42, 12-53, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-109, 12-175, 12-178, 12-226, 12-246, 12-249, 12-289, 12-311, 12-316, 14-69, 14-73, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-82, 17-159, 17-163, 17-169, 17-172, 18-116

Droplet Agglomeration (see also "Particle Agglomeration") 12-27, 17-34, 17-38, 17-169, 17-172

Droplet Collision (see also "Collisions") 12-46, 12-77, 12-79, 12-86, 12-96, 12-222, 12-246, 12-249, 12-298, 17-34, 17-82, 17-90, 17-183, 17-187, 17-196

Droplet Creation Via a Syringe (see also "Drop Formation," "Liquid Expulsion Through a Small Orifice" and "Liquid Injection") 12-27, 12-46, 12-50, 12-53, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-175, 12-184, 12-226, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Droplet Dispersion (see also "Dispersion" and "Particle Dispersion") 1-95, 1-101, 7-5, 12-42, 17-14, 17-43, 17-51, 17-56, 17-72, 17-75, 17-90, 17-92, 17-107, 17-110, 17-113, 17-116, 17-169, 17-172, 17-178, 17-187, 17-199, 17-230

Droplet Injection (see also "Liquid Injection") 12-77, 12-79, 12-82, 12-86, 12-109, 12-246, 12-249, 12-289, 12-298, 12-311, 12-316

Droplet Size (see also "Particle Size Distribution") 12-77, 12-311, 12-316, 16-25, 16-37, 17-90, 17-92, 17-107, 17-113, 17-116, 17-152, 17-163, 17-183, 17-187, 17-226

Drop Migration (see also "Particle Migration") 5-90, 5-95, 14-137, 17-34, 17-38, 17-43, 17-48, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-95, 17-99, 17-102, 17-107, 17-110, 17-113, 17-116, 17-146, 17-152, 17-163, 17-183, 17-187, 17-191, 17-196, 17-226

Drop Oscillation (see also "Drop Dynamics" and "Oscillation") 6-44, 6-48, 6-54, 12-27, 12-46, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-213, 12-226, 12-246, 12-249, 18-67, 18-73

Drop Rotation (see also "Rotating Fluids" and "Sample Rotation") 6-48, 9-84, 12-46, 12-79, 12-82, 12-98, 18-67

Drops (see also the "Drop..." and "Droplet..." titles) 1-101, 2-28, 2-33, 4-3, 5-72, 5-90, 5-95, 6-3, 6-8, 6-13, 6-44, 6-48, 6-54, 9-39, 9-84, 9-88, 10-33, 12-27, 12-42, 12-46, 12-50, 12-53, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-109, 12-175, 12-178, 12-184, 12-213, 12-222, 12-226, 12-246, 12-249, 12-289, 12-298, 12-311, 12-316, 14-69, 14-73, 14-116, 14-137, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-14, 17-34, 17-38, 17-43, 17-48, 17-51, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-82, 17-90, 17-92, 17-95, 17-99, 17-102, 17-107, 17-110, 17-116, 17-146, 17-152, 17-159, 17-163, 17-169, 17-172, 17-183, 17-187, 17-191, 17-196, 17-199, 17-222, 17-224, 17-226, 17-230, 18-15, 18-67, 18-73, 18-116, 18-215

Drop Stability (see also "Drop Dynamics," "Fluid Stability," and "Meniscus Stability") 6-44, 12-50, 12-79, 12-82, 12-86, 12-96, 12-98, 12-103, 16-25, 16-31, 16-37, 16-42, 16-58

Drop Velocity 12-77, 12-289, 12-298, 12-311, 12-316, 17-116

Drop Vibration (see also "Drop Dynamics") 12-27, 12-79, 12-82, 12-226

Ductility 6-17

Dye see "dye" in the Sample Materials Index

E

Effervescence 12-38

Elastomer Modified Epoxy Resins (see also "epoxy" in the Sample Materials Index) 17-230

Electrical Conductivity (see also "Conductivity") 1-48, 1-53, 8-48, 18-22, 18-25

Electrical Gene Transfer 1-113

Electrical Properties 8-58, 9-34, 9-69, 9-73, 10-51, 17-133, 17-136

Electrical Resistivity 14-8, 14-11, 14-38, 14-42

Electrically Induced Fusion (see "Electrofusion" or "Cell Fusion")

Electric Field 1-3, 1-6, 1-10, 1-14, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-105, 1-108, 1-111, 1-113, 1-118, 1-125, 2-37, 2-62, 8-55, 8-58, 9-14, 12-217, 12-260, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-32, 15-36, 15-41, 15-44, 15-49, 15-72, 15-81, 17-155, 18-131, 18-135, 18-212, 18-247

Electrochemical Corrosion (see also "Corrosion") 15-26

Electrochemical Environment 1-157

Electrochemical Growth 8-55, 8-58

Electrochemical Reaction 8-7

Electrocodeposition (see also "Deposition") 15-10, 15-13, 15-16, 15-19, 15-81

Electrodeposition (see also "Deposition") 8-7, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-81

Electrodes (see also "Anode" and "Cathode") 1-14, 1-17, 1-22, 1-35, 1-48, 1-53, 7-17, 7-21, 8-55, 8-58, 9-14, 11-74, 15-10, 15-13, 15-16, 15-22, 15-24, 15-26, 15-81, 18-131

Electrofusion (see also "Cell Fusion") 1-105, 1-108, 1-111, 1-113, 1-118, 1-125

Electrohydrodynamics (see also "Hydrodynamics") 1-22, 1-26

Electrolysis 8-7, 8-55, 8-58, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24

Electrolyte Solution (see also "Solutions" (this index) and "electrolyte/electrolytic" in the Sample Materials Index) 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-81, 18-212

Electromagnetic Levitator (see also "Acoustic Levitation") 6-17

Electron Beam Melting 6-3

Electronic Materials 8-12, 8-17, 8-22, 8-24, 8-27, 8-38, 8-42, 8-45, 8-48, 8-52, 8-74, 8-84, 8-88, 9-3, 9-5, 9-9, 9-14, 9-19, 9-25, 9-34, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-84, 9-88, 9-117, 9-121, 9-129, 9-144, 9-149, 9-153, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-65, 10-68, 17-18

Electron Mobility (see also "Particle Mobility") 10-51

Electroosmosis (see also "Wall Effect") 1-3, 1-6, 1-10, 1-17, 1-22, 1-26, 1-35, 1-61

Electrophoresis (see also "Cell Separation," "Continuous Flow Electrophoresis," "Dielectrophoresis," "Static Column Electrophoresis," and "Separation of Components") 1-3, 1-6, 1-10, 1-14, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-157, 15-16, 18-156, 18-159

Electroplating (see also "Plating") 18-212

Electrostatic Effects 11-3, 11-7, 12-175, 12-178

Electrotransfection 1-113

Emulsion 1-95, 4-51, 17-14, 17-142, 17-146, 17-149, 17-152, 17-155, 17-169, 17-172, 17-178, 17-199, 17-226

Emulsion Polymerization (see also the "Polymer..." titles) 18-189, 18-195, 18-199, 18-203, 18-207

Encapsulated Float Zones (see also "Coated Float Zones" and "Float Zones") 9-101, 9-106, 9-109, 9-112, 9-117, 9-121, 9-138, 9-156

Engine Re-start 12-252, 12-264

Epitactic Layers 10-68

Epitaxial Growth 8-24

Epoxy Resins (see also "epoxy" in the Sample Materials Index) 5-109, 17-230

Equiaxial Zone (see also "Columnar to Equiaxed Transition") 14-19, 14-23, 14-46

Etch Pits 8-84, 10-65

Eutectics (see also "Faceted Eutectics," "Fiber Eutectics," "Hypereutectics," "Hypoeutectics," "Lamellar Eutectics," and "Single Grain Eutectics") 4-47, 5-3, 5-7, 5-10, 5-69, 5-72, 6-3, 6-25, 6-54, 6-57, 8-92, 9-27, 9-31, 9-57, 9-67, 11-74, 14-8, 14-11, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-61, 14-80, 14-82, 14-85, 14-89, 14-93, 14-100, 14-105, 14-114, 14-124, 14-126, 14-128, 14-131, 14-134, 14-153, 14-163, 17-22, 17-26, 17-30, 17-75, 17-133, 17-136, 17-175, 17-222, 17-224, 18-8, 18-73, 18-82, 18-99, 18-111, 18-116

Eutectic Shift 14-38, 14-42

Evacuolated Protoplasts see "Protoplasts"

Evaporation (see also "Sample Evaporation" and "Vaporization") 1-140, 1-144, 1-148, 1-165, 1-170, 2-9, 5-113, 8-84, 9-57, 9-65, 9-67, 12-275, 12-284, 12-307, 12-321, 13-21, 14-100, 15-32, 15-44, 15-49, 18-139, 18-144, 18-149, 18-153, 18-173, 18-178, 18-184

Evaporators 18-139, 18-144, 18-149, 18-153, 18-162, 18-166, 18-173, 18-178, 18-184

Expansion Cloud 12-42

F

Facets 8-84, 9-9

Faceted Eutectics (see also "Eutectics") 6-57, 14-163, 17-22, 17-26

Fan-Like Structure (see also "Structure") 14-49, 14-52

Fault Spacing (see also "Spacing") 14-8, 14-11, 14-46, 14-89

Feed Material 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 9-112, 10-65

Ferromagnetic (see also the "Magnetic..." titles) 6-21, 17-120, 17-133, 17-136

Fiber in addition to the "Fiber..." titles below, see "Coated Fibers" (this index) and "fiber" in the Sample Materials Index

Fiber Dispersions (see also "Dispersion" and "Particle Dispersion") 5-10, 5-109, 5-113, 5-118, 5-130, 5-132, 5-135, 14-15, 18-252

Fiber Eutectics (see also "Eutectics") 9-27, 9-31, 14-85, 14-89, 14-131, 14-134, 18-111

Fiber Metallurgy 4-3

Fiber Optic Applications (see also the "Optic..." titles) 6-44, 9-27, 9-31

Fibers 2-13, 4-3, 5-109, 5-113, 5-118, 5-130, 5-132, 5-135, 9-27, 9-31, 14-15, 14-131, 14-134, 18-111, 18-252

Fibers (Coated) see "Coated Fibers"

Fiber Spacing see "Inter-Fiber Spacing" and "Spacing"

Fibrin Structures (see also "Structure") 1-152, 16-65

Fick's Law 11-9, 11-58

Film Growth 10-3, 10-57, 10-62, 10-65

Film Microstructure (see also "Structure") 8-24, 10-3, 10-57, 10-62

Films (see also (1) "Coated Surfaces," "Liquid Films," "Liquid Film Rupture," "Membranes," "Thin Films," "Thin Film Membranes," and "Vacuum Film Deposition" (this index), (2) "film" in the Sample Materials Index, and (3) "film" in the Container Materials Index) 8-24, 9-51, 9-54, 10-3, 10-46, 10-57, 10-62, 10-65, 10-72

Filtration 1-165, 1-170, 4-3, 8-99

Flakes see "flakes" in the Sample Materials Index

Flame Extinguishment 3-3

Flame Propagation 3-3

Flammability 3-3, 12-38

Float Zones (see also "Coated Float Zones," "Encapsulated Float Zones," "Float Zone Stability," "Liquid Bridges," and "Liquid Columns") 2-58, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-138, 9-149, 9-153, 9-156, 12-139, 12-144, 12-149, 12-153, 12-157, 12-187, 12-190, 12-206, 14-114

Float Zone Stability (see also "Float Zones," "Fluid Stability," "Liquid Stability," "Liquid Bridge Stability," and "Meniscus Stability") 9-76, 9-91, 9-106, 9-109, 9-149, 9-153, 12-190

Flotation of Bubbles 15-32

Flotation of Drops (see also "Drop") 17-102, 17-110, 17-116

Flow in addition to the "Flow..." titles below, see "Capillary Flow," "Continuous Flow Electrophoresis," "Interdendritic Fluid Flow," "Powder Flow," "Stefan Flow," "Stokes Flow," "Thermocapillary Flow," "Time Dependent Thermocapillary Flow," and "Turbulent Flow"

Flowing-Junction Cell 11-55, 11-58

Flow Rates (see also "Maximum Liquid Injection Rate") 1-35, 2-52, 2-54, 12-256, 12-271

Flow Velocity 12-131, 12-194, 12-198, 12-217, 12-222, 12-237, 12-243, 12-280, 12-307, 12-321

"Fluid..." see also "Liquid..."

Fluid Drainage 2-9, 12-34, 12-40, 18-215

Fluid Management (see also "Baffles," "Capillary Flow," "Fuel Tanks," "Gas-Free Liquid Expulsion," "Liquid Transfer," "Partially Filled Containers," "Propellant Transfer," "Refueling in Orbit," "Sloshing," and "Ventilation") 2-13, 2-62, 12-3, 12-7, 12-13, 12-18, 12-22, 12-175, 12-178, 12-184, 12-252, 12-256, 12-264, 12-275, 12-301, 18-139, 18-144, 18-149, 18-153, 18-159, 18-166, 18-173, 18-178, 18-184, 18-234

Fluid Motion Damping (see also "Vibration Isolation Systems") 1-121, 7-8, 9-54, 12-46, 12-79, 12-82, 12-90, 12-93, 12-118, 12-213, 12-256, 12-264, 12-284, 15-78, 15-81

Fluid Oscillation (see also "Oscillation") 2-54, 6-39, 6-44, 6-48, 6-54, 12-46, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-135, 12-229, 12-233, 12-264, 18-67, 18-73

Fluid Physics 12-3, 12-7, 12-13, 12-18, 12-22, 12-24, 12-27, 12-30, 12-34, 12-38, 12-40, 12-42, 12-46, 12-50, 12-53, 12-56, 12-60, 12-65, 12-71, 12-74, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-167, 12-172, 12-175, 12-178, 12-181, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-209, 12-211, 12-213, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-246, 12-249, 12-252, 12-256, 12-260, 12-264, 12-271, 12-275, 12-280, 12-284, 12-289, 12-294, 12-298, 12-301, 12-305, 12-307, 12-311, 12-316, 12-321, 18-215

Fluid Stability (see also "Bubble Stability," "Drop Stability," "Float Zone Stability," "Foam Stability," "Interface Stability," "Liquid Bridge Stability," "Liquid Dynamic Response," "Liquid Stability," "Meniscus Stability," "Phase Stability," "Stability of Dispersions," and "Stability of Suspensions") 12-139, 12-144, 12-149, 12-153, 12-157, 12-190, 12-194

Flux (see also "Flux" in the Sample Materials Index) 6-57, 18-19, 18-22, 18-25, 18-31, 18-34, 18-37, 18-49, 18-58

Foams (see also "Closed Cell Foam," "Foam Stability," "Metallic Foams," and "Polymer-Gas Foams" (this index) and "foam" in the Sample Materials Index) 2-6, 2-9, 2-26, 4-57, 5-7, 5-121, 12-27, 13-11

Foam Stability (see also "Bubble Stability," "Fluid Stability" "Foams," and "Meniscus Stability") 2-6, 2-9, 2-26, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-57

Fountain Effect 2-21, 12-271, 12-275

Freckling 14-26

Free Energy 13-21

Free Floating Crystals 16-12, 16-25

Free-Flying Satellite 8-17, 12-157, 18-144, 18-162, 18-166, 18-169

Free Surface (see also "Open Cavity" and the "Surface..." titles) 2-3, 2-13, 2-16, 2-21, 2-24, 2-28, 2-33, 2-37, 2-41, 2-46, 2-49, 2-52, 2-54, 2-58, 2-62, 4-51, 5-14, 5-18, 6-8, 6-13, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-57, 8-24, 9-5, 9-9, 9-14, 9-34, 9-76, 9-84, 9-88, 9-91, 9-98, 9-101, 9-106, 9-109, 9-112, 9-117, 9-121, 9-129, 9-138, 9-149, 9-153, 9-156, 12-3, 12-7, 12-13, 12-18, 12-24, 12-27, 12-30, 12-34, 12-40, 12-46, 12-53, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-172, 12-175, 12-178, 12-181, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-209, 12-211, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-246, 12-249, 12-256, 12-284, 12-301, 13-3, 14-114, 15-5, 17-38, 17-43, 17-48, 17-139, 17-205, 17-210, 18-8, 18-12, 18-15, 18-89, 18-92, 18-102, 18-116, 18-215, 18-234

Free Surface Elimination (see also "Coated Float Zones") 5-95, 5-99, 5-140, 9-69, 9-121, 9-149, 9-153, 9-156, 14-19, 14-23, 14-26, 17-63, 17-113, 17-163, 18-92, 18-111, 18-116

Free Surface Shape (see also "Interface Shapes" and "Meniscus Shape") 4-51, 12-264, 12-284, 17-205

Free Surface Solidification (see also "Solidification") 9-5, 9-9, 9-14, 9-19, 9-25, 9-84, 9-88, 9-121, 12-139, 12-144, 12-149, 12-153, 12-157, 12-172

Freezing (see also "Frost," "Ice" and "Snow Crystals") 1-10, 1-29, 1-86, 2-58, 8-58, 9-39, 10-28, 10-33, 15-5, 16-18, 17-155, 18-212

Freon see "Freon" in the Sample Materials Index

Frost (see also "Freezing," "Ice" and "Snow Crystals") 10-33

Fuel Tanks (see also "Fluid Management," "Liquid Reservoir," "Orbital Tankers," "Propellant Tanks," and "Refueling in Orbit") 12-3

Furnace Malfunction 5-14, 5-22, 5-72, 5-109, 5-113, 5-118, 5-126, 8-24, 8-45, 8-88, 9-31, 9-65, 9-84, 9-129, 9-156, 10-65, 10-68, 11-24, 14-76, 14-78, 14-80, 14-100, 14-114, 17-30, 17-107, 18-82

Furnace Translation (see also "Translation Rate") 14-100, 14-163, 17-26, 17-30, 17-133, 17-136, 17-175

Fuse Blowout 17-178

Fusion see "Cell Fusion" or "Electrofusion"

G

Gamma Ray Detectors 10-38, 10-43, 10-51, 10-65

Gap Filling (see also "gap filler material" in the Sample Materials Index) 18-3, 18-8, 18-12, 18-19, 18-37, 18-40

Gaps 18-215

Gas in addition to the "Gas..." titles below, see "Composites with Gases," "Liquid/Gas Dispersion," "Liquid/Gas Interface," "Outgassing," "Polymer-Gas Foams," "Solid/Gas Dispersion," and "Solid/Liquid/Gas Dispersion" (all in this index) and "gas" in the Sample Materials Index

Gas Concentration (see also "Composites With Gases" and "Concentration Distribution") 4-9, 4-13

Gaseous Convection (see also "Convection") 12-13, 12-18, 12-190, 18-131, 18-135

Gas Formation (see also "Bubble Formation" and "Hydrogen Formation") 4-24, 4-32, 4-35, 4-38, 4-41, 4-44, 4-57, 5-121, 5-124, 5-126, 5-140, 6-3, 8-7, 9-5, 9-9, 9-39, 12-60, 12-65, 12-280, 13-11, 14-100, 18-105

Gas-Free Liquid Expulsion (see also "Ventilation" and "Fluid Management") 12-7, 12-252, 12-256

Gas Ingestion 12-7, 12-256

Gas Injection (see also "Bubble Injection") 2-26, 4-55, 12-27, 12-90, 12-93, 12-289, 12-307, 12-321, 14-69, 18-64, 18-92

Gas Leakage 5-7, 5-10, 5-62, 8-84, 14-153

Gas Pressure (see also "Pressure Compensation") 2-3, 4-19, 9-57, 9-67, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-57, 10-62, 10-68, 12-24, 12-42, 18-46, 18-86, 18-135, 18-149

Gels 1-14

Gene Transfer 1-118

Gettering Dispersion Mechanism (see also "Dispersion") 5-52

G-Jitter Effects see "Acceleration Effects"

Glasses (see also (1) "Alkaline Glasses," "Glass Formation," "Glass Melts," "Heavy Metal Fluoride Glasses," and "Metallic Glasses" (this index), (2) "glass" in the Sample Materials Index, and (3) "glass" in the Container Materials Index) 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 12-103, 12-167, 14-145, 14-148, 17-59, 17-63, 17-66, 18-67, 17-69, 17-72, 18-73

Glass Formation (see also "Glasses") 6-35, 6-39, 6-48, 6-52, 6-54, 9-57, 9-61, 9-63, 9-65, 9-67, 11-40, 18-67

Glass Melts 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 12-167

Grain Boundaries 4-47, 9-14, 9-19, 9-25, 9-129, 10-51, 13-6, 17-196, 18-82

Grain Size 4-47, 5-41, 6-17, 6-44, 9-41, 9-48, 9-138, 13-21, 14-3, 14-29, 14-32, 14-167, 15-13, 18-224

Grain Structure (see also "Structure" and "Single Grain Eutectics") 4-47, 4-51, 6-17, 6-44, 9-41, 9-45, 9-48, 9-57, 9-67, 11-40, 14-3, 14-29, 14-32, 14-89, 14-93, 14-109, 14-167, 15-53, 17-18

Gravity see "Acceleration Effects" and "Processing at High Gravity Levels"

Gravity-Driven Convection see "Buoyancy-Driven Convection" or "Thermosolutal Convection"

Growth see "Bubble Growth," "Diffusion-Controlled Growth," "Film Growth," "Particle Growth," "Protein Crystal Growth," "Semi-Confined Bridgman Growth," and the "Crystal Growth...." titles

Growth Kinetics 8-22, 8-24, 8-42, 8-45, 9-54

Growth Rate (see also "Cooling Rate," "Pulling Rate," "Solidification Rate," and "Translation Rate") 5-118, 5-132, 5-135, 6-3, 6-8, 8-7, 8-34, 8-63, 8-67, 8-74, 8-95, 9-9, 9-41, 9-69, 9-73, 9-84, 9-95, 9-98, 9-101, 9-106, 9-109, 9-117, 9-121, 9-125, 9-134, 9-156, 10-51, 11-86, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-61, 14-65, 14-85, 14-89, 14-93, 14-100, 14-116, 14-128, 14-131, 14-134, 14-153, 14-159, 17-51, 17-82, 17-95, 17-133, 17-136, 18-111, 18-116

H

Halogen Cycle 18-129, 18-135

Halogen Lamps (see also "Lamps" and "Metal Halide Arc Lamps" (this index) and "lamps" in the Sample Materials Index) 1-35, 6-54, 8-38, 8-42, 8-52, 8-88, 9-76, 9-84, 9-88, 9-91, 9-106, 9-121, 14-49, 17-107, 17-113, 17-217, 18-15, 18-73, 18-125, 18-127, 18-129, 18-135

Hanging Drop Method (see also "Drop" and "Protein Crystal Growth") 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Hardness 5-22, 5-29, 5-41, 5-52, 5-99, 5-104, 6-21, 8-95, 13-11, 15-81, 17-128

Hardware Malfunction 1-57, 1-69, 1-73, 1-118, 2-52, 2-58, 5-48, 5-140, 6-3, 6-17, 6-21, 6-25, 6-39, 6-57, 8-52, 8-74, 8-81, 9-45, 9-51, 9-112, 9-121, 9-134, 10-46, 11-24, 11-58, 11-65, 11-82, 12-24, 12-53, 12-56, 12-79, 12-96, 12-98, 12-118, 12-172, 12-181, 12-187, 12-206, 12-213, 12-222, 12-246, 12-289, 12-298, 12-301, 12-311, 12-316, 14-11, 14-23, 14-105, 15-10, 15-60, 16-15, 16-22, 17-26, 17-30, 17-38, 17-43, 17-125, 17-191, 17-196, 17-226, 18-22, 18-

86, 18-111, 18-116, 18-139, 18-195, 18-199, 18-241

Heat and Mass Transfer (see also "Diffusive Mass Transfer," "Heat Transfer," "Liquid Transfer," "Mass Transfer," and "Propellant Transfer") 8-27, 8-74, 9-41, 9-98, 9-134, 9-149, 9-153, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-57, 10-62, 10-65, 10-68, 11-9, 11-37, 11-62, 12-129, 12-153, 12-157, 12-162, 12-184, 12-217, 14-137, 14-141, 14-159, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 18-12, 18-207, 18-220

Heat Capacity 7-11

Heat Conduction (see also "Conduction" and "Thermal Diffusion") 5-41, 12-13, 12-18, 14-49, 14-52, 14-69, 15-63, 15-66, 15-69

Heat Exchangers 15-41, 15-44, 15-49

Heat Flux 9-134, 14-100, 14-128, 14-131, 14-134, 15-36, 15-41, 15-44, 15-49

Heating see "Compressive Heating," "Induction Heating," "Resistance Heating," "Solar Heating," and "Superheating"

Heat of Fusion 6-57, 15-5

Heat of Reaction 14-69, 14-73

Heat of Solution 14-69, 14-73

Heat of Transport 11-62, 11-82

Heat Pipes 10-38, 10-43, 18-135, 18-139, 18-144, 18-149, 18-153, 18-156, 18-159, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184

Heat Radiators 18-139, 18-144, 18-149, 18-153, 18-162, 18-166, 18-169, 18-184

Heats of Formation 14-69, 14-73

Heat Transfer (see also "Heat and Mass Transfer") 5-35, 6-44, 9-14, 9-138, 12-13, 12-18, 12-131, 12-135, 12-139, 12-144, 12-149, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-237, 12-240, 12-243, 12-260, 12-271, 12-275, 12-289, 12-294, 14-61, 14-114, 15-5, 15-32, 15-36, 15-41, 15-44, 15-49, 15-60, 17-155, 18-135, 18-139, 18-144, 18-149, 18-153, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184, 18-234

Heat Transfer Coefficient 15-49

Heavy Metal Fluoride Glasses (see also "Glasses" and the "Metal..." titles) 6-44

Heterogeneous Nucleation (see also "Nucleation") 6-35, 6-48, 6-57, 8-34, 8-99, 11-40, 13-11, 14-89, 17-163, 17-205

Highly Reactive Materials (see also "Corrosion" and "Material Interaction with Containment Facility") 14-69, 14-73

High Performance Liquid Chromatography (see also "chromatography paper" in the Sample Materials Index) 18-250

High Stiffness Composites (see also "Composites") 5-113

High Temperature Materials 5-99, 5-104, 5-106, 6-17, 6-28, 6-32, 6-35, 13-6, 13-18

Holography 7-33, 8-74, 12-280, 12-294, 14-137, 14-141

Homogeneity (see also "Crystal Homogeneity" and "Sample Homogeneity") 7-33, 7-36, 9-101, 9-106, 9-109, 9-156, 11-79, 14-128, 14-131, 14-134, 14-167, 17-26, 17-30, 17-34, 17-48

Homogeneous Dispersion (see also "Dispersion," "Particle Dispersion," and "Sample Homogeneity") 4-24, 4-44, 4-47, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-95, 5-99, 5-104, 5-106, 13-3, 14-42, 15-10, 15-13, 17-6, 17-11, 17-56, 17-82, 17-120, 17-125, 17-128, 17-139, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224, 18-108, 18-252

Homogeneous Nucleation (see also "Nucleation") 6-48, 8-24, 11-40, 14-153

Hot-Wire Technique 15-72, 17-155

Human Bone Marrow Transplants (see also "cell" in the Sample Materials Index) 16-65

Hybrid Viability 1-125

Hydration 1-165, 1-170

Hydrodynamics (see also "Bubble Dynamics," "Drop Dynamics," "Electrohydrodynamics," and "Liquid Dynamic Response") 2-3, 2-13, 2-16, 2-19, 2-21, 2-24, 2-28, 2-33, 2-41, 2-46, 2-49, 2-52, 2-54, 12-24, 12-27, 12-30, 12-46, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-105, 12-109, 12-115, 12-123, 12-126, 12-213, 12-217, 12-243, 12-289

Hydrogen Formation (see also "Gas Formation" (this index) and "hydrogen" and "H*" in the Sample Materials Index) 15-10, 15-13, 15-22, 15-24

Hydrophobic Surfaces (see also "Coated Surfaces" (this index) and "hydrophobic coating" in the Container Materials Index) 2-46, 2-49, 12-284, 16-31

Hydrostatic Pressure 4-57, 6-3, 12-30, 12-56, 12-139, 12-144, 12-149, 12-252, 18-8, 18-12, 18-220, 18-252

Hypereutectics (see also "Eutectics" and "Hypoeutectics") 6-25, 6-57, 14-42, 14-46, 14-61, 14-93, 14-150, 14-153, 14-163, 17-175, 18-15, 18-64

Hypermonotectic Compositions (see also "Composition" and "Monotectic Compositions") 14-137, 17-139, 17-181

Hypoeutectics (see also "Eutectics" and "Hypereutectics") 6-57, 14-42, 14-93, 17-175, 18-15

I

Ice (see also "Freezing," "Frost," and "Snow Crystals") 9-39, 10-28, 10-33, 15-5

Illumination Difficulties 2-58, 12-42

Illumination System (see also "Schlieren Viewing") 2-58, 12-162, 12-229, 12-233, 12-252, 12-264, 12-284, 12-307, 12-311, 12-316, 12-321, 14-19, 14-23, 14-26, 15-22, 17-199

Immiscible Alloys (see also "Alloys," "Composites With Solid Particles," "Composites With Gases," "Dispersion Alloys," "Phase Separation," "Minority Phase," and "Systems Exhibiting a Miscibility Gap") 17-3, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-88, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-175, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224

Immiscible Fluids (see also "Phase Separation," "Minority Phase," and "Systems Exhibiting a Miscibility Gap") 1-95, 1-101, 1-161, 2-21, 12-105, 12-109, 12-115, 12-118, 12-121, 12-123, 12-126, 17-3, 17-14, 17-34, 17-38, 17-43, 17-48, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-146, 17-152, 17-155, 17-178, 17-199, 17-205, 17-226

Immune System 1-86, 1-90, 16-65

Impact Velocity (see also "Collisions") 12-246, 12-249, 12-298, 14-120

Impurities (see also "Contamination Source" and "Sample Purity") 4-3, 5-79, 5-82, 6-54, 7-17, 7-21, 8-58, 8-95, 9-39, 9-76, 9-79, 9-84, 9-95, 9-112, 10-38, 11-9, 12-65, 12-144, 12-284, 14-85, 14-112, 15-49, 18-73

Inclusion and/or Rejection of Particles (see also the "Particle..." titles) 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 12-60, 12-65, 14-112, 14-116, 15-78, 17-59, 17-75, 17-169, 17-172

Inclusions 4-27, 4-29, 4-32, 4-35, 5-69, 5-72, 5-79, 5-82, 8-45, 8-67, 8-74, 9-84, 11-55, 12-280, 17-59, 17-63, 17-75, 17-110, 17-120, 17-142, 18-82

Incomplete Sample Processing (see also "Processing Time Not As Long As Planned") 1-29, 4-3, 4-32, 4-55, 5-3, 5-45, 5-52, 5-69, 5-72, 5-83, 5-85, 5-99, 5-109, 5-118, 6-3, 6-21, 6-35, 8-12, 9-112, 9-138, 9-156, 10-65, 14-105, 17-18, 17-38, 17-72, 17-107, 18-199

Incubator 1-78, 1-86, 1-90, 1-118

Induction Heating 6-17, 6-57

Infrared Detector Applications 6-44, 8-27, 8-74, 8-84, 9-95, 9-129, 9-144, 10-65

Infrared Telescope 12-271

Infrared Transmission 9-27, 9-31, 9-144

Inorganic Crystallization (see also the "Crystal..." titles) 8-55, 8-58, 8-105

Insoluble Crystals (see also the "Crystal..." titles) 8-12, 8-17, 8-34, 8-48, 8-95

Interdendritic Fluid Flow (see also the "Dendritic..." titles) 14-61

Interdiffusion (see also "Diffusion," "Double Diffusion," "Liquid/Liquid Diffusion," and "Self-Diffusion") 11-9, 11-13, 11-17, 11-24, 11-33, 11-37, 11-44, 11-52, 11-55, 11-58, 11-70, 11-74, 11-79, 11-89, 12-56, 17-38

Interface in addition to the "Interface..." titles below, see "Convection at the Interface," "Liquid/Gas Interface," "Liquid/Liquid Interface," "Liquid/Vapor Interface," "Planar Solidification Interface," "Solid/Liquid Interface," "Solid/Solid Interface," and "Vapor/Solid Interface"

Interface Demarcation (see also "Peltier Pulsing") 9-9, 9-14, 9-73, 9-98, 9-101, 9-106, 9-109, 14-131, 14-134, 14-141

Interface Phenomena 5-22, 8-74, 9-39, 9-41, 9-45, 9-48, 9-125, 9-129, 12-105, 12-109, 12-113, 12-115, 12-118, 12-123, 12-126, 12-175, 12-178, 12-181, 14-141, 17-196, 18-99

Interface Physics 1-135, 2-6, 2-9, 2-21, 2-24, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-109, 5-113, 5-118, 5-121, 5-124, 5-126, 5-135, 5-140, 6-48, 6-54, 7-5, 7-8, 7-11, 7-24, 7-27, 8-74, 9-41, 9-45, 9-48, 9-125, 9-129, 9-134, 9-144, 11-55, 11-58, 11-91, 12-3, 12-7, 12-60, 12-65, 12-90, 12-93, 12-115, 12-175, 12-178, 12-289, 12-294, 13-11, 14-3, 14-26, 14-116, 16-65, 17-43, 17-139, 17-169, 17-172, 17-196, 18-15, 18-108, 18-111, 18-215

Interface Shapes (see also "Free Surface Shape" "Interfacial Curvature," and "Meniscus Shape") 5-57, 6-13, 9-73, 9-79, 9-81, 9-91, 9-101, 9-106, 9-109, 9-138, 9-156, 11-3, 11-13, 11-21, 11-55, 12-7, 12-13, 12-18, 12-105, 12-109, 12-256, 12-284, 14-116, 14-131, 14-159, 14-163

Interface Stability (see also "Convection at the Interface," "Fluid Stability," and "Liquid Stability") 4-51, 5-62, 5-66, 7-5, 7-8, 7-11, 7-24, 7-27, 9-19, 9-25, 9-134, 10-38, 11-86, 12-7, 12-105, 12-109, 12-115, 12-123, 12-126, 12-181, 12-284, 14-3

Interfacial Curvature (see also "Interface Shapes") 9-91, 9-109, 11-13, 11-21, 12-13, 12-105, 12-109, 12-162, 12-181, 12-194, 12-198, 14-29, 14-131

Interfacial Energy (see also "Surface Energy") 5-26, 5-29, 5-33, 5-35, 5-118, 5-135, 5-140, 12-53, 12-109, 14-120, 17-34, 17-38, 17-43, 17-48, 17-51, 17-59, 17-128, 17-152, 17-183, 17-187

Interfacial Tension (see also "Surface Tension") 1-95, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-162, 12-289, 12-311, 12-316, 14-116, 17-95, 17-99, 17-102, 17-116, 17-199, 17-210, 17-226, 18-92, 18-99, 18-105, 18-215

Interferometric Measurement 7-33, 8-30, 11-58, 12-118, 12-121, 12-198, 12-206, 14-137, 14-141, 15-49

Inter-Fiber Spacing (see also "Spacing" and the "Fiber..." titles) 9-27, 9-31, 14-85, 14-89, 14-131, 14-134

Intermetallics (see also the "Metal..." titles) 6-3, 9-79, 9-81, 13-21, 14-15, 17-18, 17-120, 17-125, 17-128, 18-3

Interrod Spacing (see also "Spacing" and "Rod Structure") 17-133, 17-136, 17-175

Ion Exchange 8-95, 11-13, 11-52

Ionic Solution (see also "Solutions") 7-17, 7-21, 15-10, 15-13, 15-16, 15-19, 15-81

Isochoric Specific Heat 7-11

Isodensity Systems (see also "Plateau Setup") 7-24, 7-27

Isoelectric Focusing 1-22, 1-26

Isotachophoresis 1-17, 1-29

Isothermal Processing 5-22, 5-26, 5-29, 6-25, 13-3, 14-49, 14-52, 14-80, 15-53, 16-12, 16-15, 16-18, 17-6, 17-11, 17-14, 17-22, 17-43, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-82, 17-86, 17-92, 17-107, 17-113, 17-125, 17-191, 17-217, 18-15, 18-189, 18-195, 18-199, 18-207

Isotope Effect 11-65, 11-70

Isotopes (see also "Radioactive Tracer Diffusion") 11-65, 18-3

K

Kirkendall-Effect 11-70

L

Lamellar Eutectics (see also "Eutectics") 5-7, 6-48, 6-57, 14-8, 14-11, 14-82, 14-85, 14-89

Lamellar Structure (see also "Structure") 4-32, 4-41, 4-47, 14-8, 14-11, 14-46, 14-85, 14-89, 17-6, 17-22, 18-116

Lamps (see also "Halogen Lamps" and "Metal Halide Arc Lamps" (this index); "lamps" in the Sample Materials Index; "mirror furnace" in the Processing Facility Index) 8-84, 9-81, 9-98, 9-101, 9-109, 9-117, 14-19, 14-23, 14-26

Laser see "Liquid Lasers"

Laser Beam Diffraction 15-63, 15-66, 15-69

Laser Light Scattering 7-36, 15-63, 15-66, 15-69, 15-78

Launch-Induced Fluid Motion 9-41, 9-54, 12-3, 12-60, 12-65, 12-71, 12-74, 12-252, 12-316, 14-35, 15-10, 18-15

Lens Formation (see also the "Meniscus..." titles) 12-40, 12-172

Levitation/Levitators see "Acoustic Levitation" and "Electromagnetic Levitator"

Linear Conductors (see also "Conductance" and "Conductors") 8-55, 8-58

"Liquid..." see also "Fluid..."

Liquid Bridges (see also "Liquid Columns" and "Float Zones") 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 2-58, 12-30, 12-129, 12-131, 12-135, 12-139, 12-187, 12-190, 12-206, 12-217, 12-222, 12-237, 12-240, 12-243, 13-3, 17-205, 17-217

Liquid Bridge Stability (see also "Float Zone Stability," "Fluid Stability," and "Meniscus Stability") 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 2-58, 12-30, 12-135, 12-144, 12-190, 12-217, 12-222, 17-205, 17-217

Liquid Chromatography see "High Performance Liquid Chromatography"

Liquid Column Rupture 2-33, 2-37, 2-41, 2-54, 2-58, 9-91, 9-156, 12-30, 12-222

Liquid Columns (see also "Liquid Bridges" and "Float Zones") 2-33, 2-37, 2-41, 2-52, 2-54, 12-30, 12-139, 12-144, 12-149, 12-153, 12-157, 17-205, 18-116

Liquid Crystals 1-101, 12-13, 12-18, 18-149

Liquid Demixing (see also "Liquid Mixing," "Immiscible Fluids," "Immiscible Alloys," "Phase Separation," and "Separation of Components") 1-95, 1-101, 17-178, 17-191, 17-196, 17-199, 17-205, 17-226, 17-230

Liquid Dynamic Response (see also "Bubble Dynamics," "Drop Dynamics," "Electrohydrodynamics," "Fluid Stability," "Hydrodynamics" and the "Vibration..." titles) 2-33, 2-41, 2-46, 2-49, 2-54, 6-44, 6-48, 6-54, 7-8, 12-3, 12-24, 12-27, 12-30, 12-46, 12-79, 12-82, 12-86, 12-93, 12-96, 12-98, 12-103, 12-105, 12-118, 12-178, 12-213, 12-217, 12-226, 12-229, 12-233, 12-246, 12-249, 12-256, 12-264, 12-275, 12-298, 12-301, 15-78, 15-81, 18-67, 18-73

Liquid Expulsion Through a Small Orifice (see also "Droplet Creation Via a Syringe" and "Liquid Injection") 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-90, 2-6, 2-9, 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 2-58, 4-57, 11-3, 12-13, 12-18, 12-27, 12-30, 12-34, 12-46, 12-50, 12-53, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-109, 12-135, 12-175, 12-178, 12-184, 12-217, 12-222, 12-226, 12-237, 12-240, 12-243, 12-246, 12-249, 12-289, 12-298, 12-311, 12-316, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-205, 18-215

Liquid Film Rupture (see also "Films") 9-109, 9-121, 9-156, 12-34

Liquid Films (see also "Films") 2-37, 2-41, 12-34, 12-40

Liquid/Gas Dispersion (see also "Bubble Dispersion," "Dispersion," "Particle Dispersion," "Homogeneous Dispersion," and "Gas") 2-6, 2-9, 4-3, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-29, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 4-57, 5-3, 5-7, 5-10, 17-3

Liquid/Gas Interface (see also "Containerless Processing," "Liquid/Vapor Interface," and the "Gas..." and "Interface..." titles) 2-3, 2-6, 2-9, 2-13, 2-16, 2-19, 2-21, 2-24, 2-26, 2-28, 2-33, 2-37, 2-41, 2-46, 2-49, 2-52, 2-54, 2-58, 2-62, 4-3, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-29, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 4-57, 5-3, 5-7, 5-10, 5-90, 6-3, 6-8, 6-13, 6-17, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 8-7, 9-39, 9-84, 9-88, 9-91, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-138, 9-149, 9-153, 9-156, 11-28, 12-13, 12-18, 12-24, 12-27, 12-30, 12-34, 12-40, 12-46, 12-50, 12-53, 12-60, 12-65, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-167, 12-172, 12-175, 12-178, 12-184, 12-187, 12-190, 12-194, 12-198, 12-206, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-264, 12-280, 12-284, 12-289, 12-294, 12-301, 12-305, 12-307, 12-316, 12-321, 13-11, 14-69, 14-114, 14-116, 15-5, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 17-3, 17-59, 17-199, 18-15

Liquid Injection (see also "Bubble Injection," "Drop Formation," "Droplet Creation Via a Syringe," "Droplet Injection," "Flow Rates," "Maximum Liquid Injection Rate," and "Liquid Expulsion Through a Small Orifice") 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-90, 2-28, 2-33, 2-37, 2-41, 2-49, 2-52, 2-54, 2-58, 4-57, 11-55, 11-58, 12-27, 12-79, 12-82, 12-86, 12-175, 12-178, 12-198, 12-206, 12-222, 12-237, 12-240, 12-243, 12-289, 12-311, 12-316

Liquid Lasers 18-244

Liquid Leakage (see also "Contamination Source") 1-17, 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-3, 2-62, 2-65, 5-

14, 5-72, 5-95, 5-99, 5-130, 5-140, 8-81, 8-99, 8-105, 11-91, 11-95, 12-162, 12-213, 14-26, 14-78, 15-72, 16-25, 16-31, 16-65, 16-70, 17-82, 17-113, 17-191, 18-244

Liquid/Liquid Diffusion (see also "Diffusion," "Double Diffusion," "Interdiffusion," and "Self-Diffusion") 1-128, 1-135, 1-152, 1-157, 1-161, 2-65, 8-12, 8-17, 8-34, 8-48, 8-63, 8-67, 8-95, 8-99, 8-105, 11-3, 11-7, 11-9, 11-13, 11-17, 11-24, 11-33, 11-37, 11-44, 11-48, 11-50, 11-52, 11-55, 11-58, 11-79, 11-95, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-63, 16-65

Liquid/Liquid Dispersion (see also "Dispersion," Homogeneous Dispersion" and "Particle Dispersion") 1-14, 1-95, 1-101, 12-289, 17-3, 17-6, 17-11, 17-14, 17-18, 17-82, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-139, 17-142, 17-146, 17-149, 17-152, 17-155, 17-159, 17-163, 17-169, 17-172, 17-181, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-214, 17-217, 17-222, 17-224, 17-226

Liquid/Liquid Interface (see also the "Interface..." titles) 1-3, 1-10, 1-14, 1-17, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-95, 1-101, 1-128, 1-135, 1-152, 1-157, 1-161, 2-21, 8-12, 8-17, 8-48, 8-63, 8-67, 8-95, 8-99, 8-105, 9-101, 9-106, 9-109, 9-117, 9-121, 11-3, 11-7, 11-13, 11-17, 11-24, 11-33, 11-37, 11-44, 11-52, 11-55, 11-58, 11-79, 11-95, 12-38, 12-53, 12-56, 12-71, 12-74, 12-86, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-213, 12-222, 12-289, 12-311, 12-316, 14-137, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-63, 16-65, 17-3, 17-6, 17-14, 17-18, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-146, 17-149, 17-152, 17-159, 17-163, 17-169, 17-172, 17-175, 17-178, 17-181, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-214, 17-217, 17-222, 17-224, 17-226, 17-230

Liquid Mixing (see also "Acoustic Mixing," "Convection," "Miscible Fluids," "Liquid Demixing," "Stirring of Components," and "Ultrasonic Mixing") 1-78, 1-95, 1-101, 1-113, 2-6, 2-9, 4-57, 8-30, 8-67, 11-95, 12-27, 12-46, 12-56, 12-71, 12-74, 12-86, 12-96, 15-78, 16-15, 16-22, 16-48, 16-53, 16-58, 17-3, 17-6, 17-14, 17-18, 17-146, 17-155, 17-178, 17-199, 17-205, 17-226, 18-3, 18-8, 18-12, 18-252

Liquid Phase Epitaxy 9-51, 9-54

Liquid Phase Sintering (see also "Sintering") 5-3, 13-3, 13-6, 13-11, 13-14, 13-16, 13-18, 13-21, 17-59

Liquid Reservoir (see also "Contained Fluids," "Containers," "Fuel Tanks," and "Propellant Tanks") 2-3, 2-13, 2-16, 2-21, 2-26, 2-28, 2-33, 2-46, 2-49, 2-52, 2-54, 8-12, 8-17, 8-34, 8-48, 8-63, 8-67, 8-95, 11-55, 11-58, 12-3, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-194, 12-198, 12-201, 12-206, 12-252, 12-256, 12-264, 12-280, 12-284, 12-289, 16-3, 16-8, 16-10, 16-12, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 17-155, 18-252

Liquid Spreading (see also "Wetting" (this index) and "anti-spreading coatings" in the Container Materials Index) 2-9, 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 5-90, 12-53, 12-175, 12-178, 12-181, 12-184, 12-194, 12-217, 17-59, 17-205, 18-8, 18-12, 18-15, 18-19, 18-31, 18-34, 18-37, 18-40, 18-49, 18-52, 18-215

Liquid Stability (see also "Fluid Stability") 1-26, 1-29, 1-95, 2-28, 6-44, 12-79, 12-82, 12-86, 12-93, 12-96, 12-98, 12-103, 12-135, 12-175, 12-264, 14-124, 14-126, 17-205, 17-217

Liquid Transfer (see also "Fluid Management," "Heat and Mass Transfer," "Mass Transfer," and "Propellant Transfer") 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-125, 2-3, 2-13, 2-16, 2-19, 2-21, 2-24, 2-28, 2-52, 2-54, 2-62, 2-65, 9-9, 11-3, 11-7, 11-55, 11-58, 12-3, 12-7, 12-13, 12-18, 12-34, 12-38, 12-79, 12-135, 12-175, 12-178, 12-184, 12-194, 12-198, 12-201, 12-206, 12-217, 12-222, 12-237, 12-240, 12-243, 12-252, 12-256, 12-264, 12-271, 12-280, 12-284, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-58, 17-113, 17-155, 17-191, 17-205, 18-156, 18-159, 18-169, 18-173, 18-178, 18-184, 18-215, 18-234, 18-244, 18-252

Liquid/Vapor Interface (see also "Liquid/Gas Interface" and the "Interface..." titles) 7-8, 12-3, 12-7, 12-42, 12-178, 12-252, 12-256, 12-271, 12-275, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-120, 17-128, 18-3, 18-139, 18-149, 18-153, 18-159, 18-173, 18-178, 18-184, 18-234

Liquid Vibration (see also the "Vibration..." titles) 2-3, 2-33, 2-41, 6-44, 6-48, 8-74, 12-30, 12-79, 12-82, 12-226

Lubricants 18-215

Lymphocyte Activation 1-86, 1-90

Lymphocytes see "Biological Cells" (this index) and "cell" and "lymphocytes" in the Sample Materials Index

Lymphokines (see also "Biological Cells") 1-86, 1-90

M

Macromolecular Aggregates (see also "Particle Aggregation") 1-140, 1-144, 1-148, 1-165, 1-170

Macromolecular Assembly 1-135, 1-152

Macrosegregation (see also "Segregation") 4-51, 9-5, 9-9, 9-14, 9-34, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-61, 14-65, 14-93, 14-109, 14-163, 17-26, 17-34, 17-175

Macrovoids (see also "Voids") 1-165, 1-170

Magnetic in addition to the "Magnetic..." titles below, see "Electromagnetic Levitator" and "Ferromagnetic"

Magnetic Composites (see also "Composites") 14-163, 17-22, 17-26, 17-30, 17-120, 17-125, 17-128, 17-133, 17-136, 17-175

Magnetic Fields 6-17, 6-21, 6-57, 14-15, 14-120, 17-26, 17-30

Magnetic Properties 17-6, 17-22, 17-120, 17-125, 17-128, 17-133, 17-136, 17-175

Marangoni Convection (see also "Convection", "Oscillatory Marangoni Convection", "Surface Tension-Driven Convection," and "Thermocapillary Convection") 2-58, 4-27, 4-29, 5-14, 5-62, 5-126, 5-140, 9-19, 9-25, 9-69, 9-76, 9-84, 9-88, 9-91, 9-98, 9-112, 9-117, 9-121, 9-149, 9-153, 11-65, 11-70, 11-86, 12-13, 12-18, 12-56, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-209, 12-211, 12-217, 12-222, 12-237, 12-240, 12-243, 12-280, 12-284, 12-289, 12-294, 12-307, 12-311, 12-316, 12-321, 14-97, 14-100, 14-114, 14-159, 15-22, 15-32, 15-36, 15-41, 15-44, 15-49, 17-34, 17-38, 17-43, 17-69, 17-72, 17-75, 17-102, 17-107, 17-110, 17-113, 17-116, 17-120, 17-128, 17-139, 17-142, 17-146, 17-152, 17-163, 17-205, 17-210, 18-111

Marangoni Convection Diminished (see also "Absence of Convection") 9-101, 9-109, 9-112, 9-117, 12-162, 17-69, 17-72, 17-128, 18-111

Marangoni Force 5-99, 5-118, 17-183, 17-187

Marangoni Movement (Migration) of Bubbles (see also "Bubble Migration," "Bubble Motion," "Bubble Transport," "Particle Migration," and "Thermomigration") 4-44, 5-140, 12-65, 12-167, 12-217, 12-289, 12-294, 15-41

Marangoni Movement of Droplets (see also "Drop," "Drop Migration," "Particle Migration," "Particle Motion," and "Thermomigration") 12-311, 12-316, 14-137, 17-38, 17-43, 17-48, 17-59, 17-75, 17-92, 17-95, 17-99, 17-102, 17-107, 17-110, 17-113, 17-116, 17-120, 17-146, 17-152, 17-183, 17-187, 17-214, 18-116

Mass Measurement 18-61

Mass-Spring Oscillation (see also "Oscillation") 18-61

Mass Transfer (see also "Diffusion," "Diffusive Mass Transfer," "Heat and Mass Transfer," "Liquid Transfer," and "Propellant Transfer")

1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 2-13, 2-65, 8-30, 8-34, 8-67, 8-84, 8-88, 9-54, 10-7, 10-12, 10-16, 10-20, 10-24, 10-33, 10-38, 10-43, 10-51, 10-65, 10-68, 11-3, 11-7, 11-40, 12-22, 12-79, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-280, 12-284, 12-307, 12-321, 15-3, 15-26, 17-72, 17-75, 18-8, 18-15

Material Interaction With Containment Facility (i.e.: crucible walls; see also "Contained Fluids," "Containers," "Crucible Effects," "Corrosion," "Highly Reactive Materials," and "Sample Detachment from Crucible") 5-18, 5-82, 6-8, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-54, 6-57, 8-12, 8-34, 9-27, 14-69, 14-73, 14-105, 14-153, 14-159, 14-163, 17-38, 17-48, 17-51, 17-63, 17-69, 17-72, 17-82, 17-92, 17-142, 17-181, 17-210

Material Strength (see also "Dispersion Strengthening" and "Tensile Strength") 4-3, 4-47, 4-55, 4-57, 5-10, 5-14, 5-22, 5-41, 5-45, 5-48, 5-52, 5-99, 5-104, 5-106, 5-109, 5-113, 6-21, 13-11, 14-15, 14-38, 14-150, 14-153, 14-167, 18-22, 18-25, 18-28, 18-58, 18-252

Maximum Liquid Injection Rate (see also "Flow Rates" and "Liquid Injection") 2-52, 2-54, 2-58

Mechanical Slippage 10-51

Mechanical Strength 14-167, 18-15

Medical Applications (see also "Biotechnology" and "Pharmaceutical Applications") 1-3, 1-6, 1-10, 1-29, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-86, 1-90, 1-105, 1-108, 1-111, 1-113, 1-118, 1-121, 1-125, 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-161, 1-165, 1-170, 16-65

Melt and Solidification (see also "Crystal Growth from the Melt" and "Solidification") 4-3, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-99, 5-104, 5-106, 5-113, 5-116, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-3, 6-8, 6-13, 6-17, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 8-22, 8-24, 8-52, 8-92, 9-3, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-41, 9-45, 9-48, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 9-95, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-125, 9-129, 9-134, 9-138, 9-144, 9-149, 9-153, 9-156, 11-9, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 11-62, 11-74, 11-79, 11-82, 11-86, 12-56, 12-60, 12-65, 12-71, 12-74, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-167, 12-172, 12-187, 12-190, 13-3, 13-6, 13-11, 13-18, 13-21, 14-3, 14-8, 14-11, 14-15, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-55, 14-57, 14-59, 14-61, 14-65, 14-69, 14-73, 14-76, 14-78, 14-80, 14-82, 14-85, 14-89, 14-93, 14-97, 14-100, 14-105, 14-109, 14-112, 14-114, 14-116, 14-124, 14-126, 14-128, 14-131, 14-134, 14-137, 14-141, 14-145, 14-148, 14-150, 14-159, 14-163, 14-167, 15-53, 15-63, 15-66, 15-69, 17-3, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-175, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224, 17-230, 18-3, 18-8, 18-12, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-58, 18-64, 18-67, 18-71, 18-73, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123, 18-220, 18-224

Melting (Without Resolidification) 15-5

Membranes (see also "Films," "Polymer Membranes," "Semipermeable Membranes," and "Thin Film Membranes") 1-48, 1-140, 1-144, 1-148, 1-165, 1-170, 8-99, 16-5, 16-8, 16-10, 16-25, 16-31, 16-63

Meniscus Shape (see also "Free Surface Shape" and "Interface Shapes") 2-16, 2-19, 2-21, 2-24, 2-28, 2-33, 2-37, 2-41, 2-54, 2-58, 4-51, 5-140, 6-8, 6-13, 8-24, 9-91, 9-156, 12-40, 12-53, 12-162, 12-172, 12-178, 12-194, 12-198, 12-226, 12-229, 12-233, 13-3, 14-163, 17-205, 17-217, 18-3, 18-15, 18-116, 18-215

Meniscus Stability (see also "Bubble Stability," "Drop Stability," "Foam Stability," "Float Zone Stability," and "Fluid Stability") 2-21, 2-28, 2-33, 2-37, 2-41, 2-54, 12-264, 17-217

Meniscus Vibration (see also the "Vibration..." titles) 2-33, 2-54, 12-226, 12-264

Metabolism 1-121, 1-125

Metal/Metallic in addition to the "Metal..." titles below, see also (1) "Adhesion of Metals," "Collision of Metals," "Fiber Metallurgy," "Heavy Metal Fluoride Glasses," "Intermetallics," "Powder Metallurgy," and "X-Ray of Liquid Metal in Space" (this index) and (2) "metal/metallic" (in the Sample Materials Index)

Metal Halide Arc Lamps (see also "Halogen Lamps" and "Lamps" (this index) and "lamps" in the Sample Materials Index) 18-131

Metallic Bonding 14-105

Metallic Dispersion (see also "Dispersion," "Homogeneous Dispersion," "Composites With Solid Particles," "Metallic Matrix," "Immiscible Alloys," and "Particle Dispersion") 14-116, 17-75, 17-159, 17-163, 17-169, 17-172, 17-183, 17-187, 17-191, 17-196

Metallic Foams (see also "Foams") 4-9, 4-13, 4-19, 4-22, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-55, 5-7

Metallic Glasses (see also "Glasses") 6-21

Metallic Matrix (see also "Composites With Gases," "Composites With Solid Particles," "Immiscible Alloys," and "Systems Exhibiting a Miscibility Gap") 4-16, 4-19, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-47, 4-51, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-113, 5-118, 5-121, 5-126, 5-130, 5-132, 5-135, 5-140, 14-52, 15-10, 15-13, 15-16, 15-19, 15-81, 17-43, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-80, 17-82, 17-86, 17-90, 17-92, 17-95, 17-102, 17-110, 17-116, 17-120, 17-125, 17-128, 17-136, 17-139, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-175, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224

Metallic Oxides 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-121, 5-126, 6-57

Metallic Solutions (see also "Solutions") 8-24, 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 10-3

Metal Purification (see also "Sample Purity") 14-112

Metals 4-3, 5-3, 5-7, 5-10, 9-138, 10-46, 10-72, 11-86, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-159, 17-163, 17-169, 17-172, 17-183, 17-187, 18-3, 18-8, 18-12, 18-15, 18-19, 18-64, 18-67, 18-212

Metals (Adhesion of) see "Adhesion of Metals"

Metals and Alloys (see also "Alloys") 4-9, 4-13, 4-16, 4-19, 4-24, 4-27, 4-29, 4-47, 4-51, 4-55, 6-21, 6-25, 6-52, 6-57, 11-70, 11-79, 11-86, 11-89, 13-3, 13-6, 13-18, 13-21, 14-3, 14-8, 14-11, 14-15, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-55, 14-57, 14-59, 14-61, 14-65, 14-69, 14-73, 14-76, 14-78, 14-80, 14-82, 14-85, 14-89, 14-93, 14-97, 14-100, 14-105, 14-109, 14-112, 14-114, 14-116, 14-120, 14-124, 14-126, 14-128, 14-131, 14-134, 14-137, 14-141, 14-145, 14-148, 14-150, 14-153, 14-159, 14-163, 14-167

Microcrystalline Dispersion (see also the "Crystal..." titles and "Dispersion") 6-57, 8-105

Microsegregation 9-5, 9-9, 9-14, 9-34, 14-57, 14-93

Minority Phase (see also the "Phase..." titles) 13-21, 17-102, 17-110, 17-116, 17-149, 17-152, 17-183, 17-187, 17-222, 17-224

Mirror Production 10-72

Miscible Fluids (see also "Liquid Mixing") 2-65

Mitogen 1-86, 1-90

Mixing see "Liquid Mixing" and "Liquid Demixing"

Model Materials 5-14, 5-18, 5-29, 5-48, 5-52, 5-57, 5-62, 5-66, 5-90, 5-95, 6-28, 6-32, 8-38, 8-42, 8-63, 8-99, 9-41, 9-45, 9-48, 10-57, 11-17, 11-24, 11-37, 11-40, 11-44, 11-48, 11-91, 14-8, 14-11, 14-19, 14-23, 14-26, 14-32, 14-116, 14-128, 14-131, 14-134, 14-137, 14-141, 15-5, 17-59, 17-63, 17-66, 17-69, 17-72, 17-146, 17-152, 17-205, 17-210, 17-226, 18-220, 18-224

Molten Salts (see also the "Salt..." titles (this index) and "salt" in the Sample Materials Index) 9-27, 9-31, 11-52, 11-55, 11-58, 11-74, 15-63, 15-66, 15-69

Monodisperse Latex Particles (see also "Dispersion," "Polystyrene Latex Microspheres," and the "Particle..." titles (this index) and "latex" and "particles" in the Sample Materials Index) 1-6, 1-53, 18-189, 18-195, 18-199, 18-203, 18-207

Monotectic Compositions (see also "Composition" and "Hypermonotectic Compositions") 11-79, 14-137, 14-141, 17-18, 17-51, 17-80, 17-110, 17-116, 17-139, 17-169, 17-181, 17-183, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224

Monotectic Temperature 11-79

Multiphase Media (see also "Two-Phase System" and the "Phase..." titles) 4-27, 4-32, 4-35, 4-38, 4-41, 4-47, 4-57, 5-90, 5-95, 12-167, 12-289, 12-294, 14-15, 14-38, 14-42, 14-69, 14-73, 14-85, 14-89, 14-116, 17-3, 17-6, 17-18, 17-26, 17-30, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-222, 17-224, 17-226, 18-116, 18-215

Mushy Zone 9-19, 9-25, 14-61, 14-65, 18-82

N

Necking (Sample) see "Sample Necking"

Needles 8-63, 8-67, 8-95, 8-99, 14-89, 14-128, 14-131, 16-42, 17-217

New Polymorphs 10-57, 10-62

Nonlinear Optical Materials (see also the "Optic..." titles) 8-63, 8-67

Non-Wetting of Container (see also (1) "Coated Surfaces," "Crucible Effects," "Sample Detachment from Crucible," and the "Container..." and "Wetting..." titles (this index) and (2) the "anti-spreading..." and "anti-wetting..." titles in the Container Materials Index) 1-101, 2-16, 2-24, 2-46, 4-51, 5-14, 5-18, 5-48, 8-24, 9-5, 9-9, 9-14, 9-19, 9-25, 9-106, 9-121, 9-138, 9-144, 11-55, 11-58, 12-13, 12-53, 12-56, 12-162, 12-184, 13-21, 14-11, 17-26, 17-38, 18-102, 18-105, 18-116

Nucleate Pool Boiling (see also "Boiling") 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49

Nucleating Agents 11-40

Nucleation (see also "Bubble Nucleation," "Homogeneous Nucleation," "Heterogeneous Nucleation," and "Spurious Nucleation") 4-47, 5-72, 6-3, 6-17, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 7-5, 7-8, 7-24, 7-27, 8-3, 8-12, 8-24, 8-34, 8-55, 8-58, 8-99, 9-41, 9-48, 9-81, 9-138, 10-20, 10-24, 10-38, 10-43, 10-51, 11-40, 12-42, 12-60, 12-65, 14-19, 14-29, 14-38, 14-42, 14-89, 14-124, 14-126, 14-137, 14-153, 14-163, 16-22, 16-37, 16-42, 16-48, 17-38, 17-51, 17-69, 17-146, 17-152, 17-159, 17-163, 17-191, 17-196, 17-205, 18-189, 18-195, 18-199, 18-203, 18-207

Nucleation Sites 8-7, 8-34, 8-99, 10-43, 11-40, 16-22, 16-37, 16-42

O

Occlusions 8-63

Open Boat (see also "Free Surface") 12-162

Open Cavity (see also "Cavity" and "Free Surface") 12-162, 12-194, 12-198, 12-201

Optic in addition to the "Optical/Optics..." titles below, see "Fiber Optic Applications," "Nonlinear Optical Materials," and "Shadow Optics"

Optical Characterization 10-57, 10-62, 12-40

Optical Transmission 9-27, 9-31, 10-72

Optics Applications 6-28, 6-32, 6-39, 8-12, 8-17, 8-27, 8-48, 8-63, 8-74, 9-27, 9-31, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-149, 9-153, 10-72, 11-33, 11-37, 11-44, 14-11

Optics Assembly 12-213, 12-229, 12-237

Orbital Tankers (see also "Fuel Tanks") 12-256

Ordered Organics 10-57, 10-62

Organic Crystals (see also the "Crystal..." titles) 8-12, 8-17, 8-48, 8-63, 8-67, 10-57, 10-62, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15

Organic Systems 5-57, 5-62, 5-66, 10-57, 10-62, 11-91, 12-105, 12-109, 12-115, 12-123, 12-126, 12-162

Oscillation see "Axial Oscillations," "Chemical Oscillations," "Drop Oscillation," "Fluid Oscillation," "Mass-Spring Oscillation," the "Oscillation..." titles (below), "Steady to Oscillatory Convective Transition," and "Thermal Oscillations"

Oscillation Amplitude 12-96, 12-98, 12-103, 12-144, 12-157, 12-226, 12-233, 12-264, 12-275

Oscillation Frequency (see also "Resonant Frequency") 12-30, 12-96, 12-98, 12-103, 12-139, 12-144, 12-149, 12-153, 12-157, 12-226, 12-233, 12-264, 12-275, 18-61

Oscillation Modes 12-46, 12-135

Oscillatory Marangoni Convection (see also "Marangoni Convection") 9-76, 9-91, 9-98, 9-109, 9-112, 9-117, 9-121, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-190, 12-194, 12-198, 12-201, 12-237, 12-243

Ostwald Ripening 5-121, 8-63, 8-67, 13-11, 17-90, 17-92, 17-163, 17-191, 17-196

Outgassing (see also "Gas" and "Ventilation") 4-44, 6-3, 9-156, 10-57, 10-72, 18-12

Oxidation 5-3, 5-29, 5-52, 6-48, 9-138, 10-72, 13-21, 14-105, 14-167, 15-26, 18-15, 18-86, 18-102, 18-241

Oxide in addition to "Oxide Layer" below, see "Metallic Oxides"

Oxide Layer 4-13, 4-47, 5-29, 9-9, 9-109, 9-112, 9-138, 9-156, 14-69, 15-26, 17-56

P

Packing Material 18-250

Paint on Canvas 18-241

Paper Formation 18-252

Partially Filled Containers (see also "Contained Fluids," "Containers," "Fluid Management," "Fuel Tanks," and "Sloshing") 2-16, 12-3, 12-7, 12-24, 12-194, 12-198, 12-201, 12-229, 12-233, 12-252, 12-256, 12-264, 12-271, 12-275, 12-284, 12-301, 12-305, 18-234

Particle in addition to the "Particle..." titles below, see also (1) "Composites with Solid Particles," "Inclusion and/or Rejection of Particles," "Monodisperse Latex Particles," and the "Drop..." titles (this index) and (2) "particles" in the Sample Materials Index

Particle Agglomeration (see also "Droplet Agglomeration") 5-18, 5-22, 5-29, 5-118, 5-121, 5-126, 5-135, 6-17, 8-105, 12-22, 13-6, 13-11, 15-16, 15-22, 17-181, 18-82, 18-105

Particle Aggregation (see also "Macromolecular Aggregates") 1-35, 1-90, 4-47, 5-3, 17-199

Particle Attraction (see also "Surface Charge" and "Electrophoresis") 13-6, 15-78

Particle Coalescence (see also "Bubble Coalescence" and "Drop Coalescence") 1-95, 4-47, 5-22, 5-90, 5-95, 5-118, 12-289, 17-75, 17-139, 17-142, 17-191

Particle Coarsening (see also "Coarsening") 5-118, 17-191, 17-196

Particle Dispersion (see also "Dispersion," "Bubble Dispersion," "Composites with Solid Particles," "Dopant Distribution," "Metallic Dispersion," "Monodisperse Latex Particles," "Suspension of Particles," and "Tracer Particles") 1-3, 1-6, 1-10, 1-14, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-86, 1-90, 1-95, 4-27, 4-32, 4-35, 4-47, 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-109, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-17, 6-39, 7-8, 8-105, 9-19, 9-25, 13-3, 13-6, 13-11, 13-18, 13-21, 14-52, 14-116, 15-3, 15-10, 15-13, 15-16, 15-19, 15-76, 15-78, 15-81, 17-3, 17-18, 17-22, 17-56, 17-72, 17-75, 17-82, 17-90, 17-92, 17-120, 17-125, 17-128, 17-133, 17-136, 17-169, 17-172, 17-175, 17-191, 17-196, 17-199, 17-214, 18-82, 18-105, 18-108, 18-220, 18-224, 18-250, 18-252

Particle Distribution (see also "Bubble Distribution," "Dopant Distribution," and "Particle Size Distribution") 1-10, 1-14, 1-35, 1-95, 5-3, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-17, 13-3, 13-21, 14-52, 15-10, 15-13, 15-16, 15-19, 15-81, 17-116, 17-120, 17-125, 17-128, 17-230, 18-105, 18-108, 18-224, 18-252

Particle Formation 5-52

Particle Growth (see also "Bubble Growth" and the "Growth..." titles) 5-29, 12-42, 12-178, 13-6, 17-120, 17-142, 17-146, 17-149, 17-152, 17-159, 17-163, 17-172, 17-183, 17-199, 18-189, 18-195, 18-199, 18-203, 18-207

Particle Inclusion and/or Rejection see "Inclusion *and/or* Rejection of Particles"

Particle Migration (see also "Bubble Migration," "Bubble Transport," "Drop Migration," "Marangoni Movement (Migration) of Bubbles," "Marangoni Movement of Droplets," and "Thermomigration") 1-6, 1-10, 1-17, 1-22, 1-26, 1-29, 5-95, 17-75, 17-191, 17-196, 17-214

Particle Mobility (see also "Electron Mobility") 1-3, 1-17, 1-22, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 15-3, 15-10, 15-13, 15-16, 15-19, 15-78, 15-81, 16-65

Particle Motion (see also "Brownian Motion") 1-3, 1-6, 1-22, 1-26, 1-86, 1-157, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-99, 5-104, 5-106, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 12-42, 12-289, 12-311, 12-316, 14-116, 15-3, 15-10, 15-13, 15-16, 15-19, 15-57, 15-76, 15-78, 15-81, 17-183, 17-187, 17-210, 18-82, 18-105

Particle Repulsion 15-78

Particle Separation (see also "Separation of Components") 13-6, 18-250

Particle Size Distribution (see also "Droplet Size," "Particle Distribution," and "Monodisperse Latex Particles") 5-62, 5-66, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-99, 5-104, 8-105, 12-65, 13-6, 17-22, 17-56, 17-75, 17-82, 17-90, 17-92, 17-107, 17-120, 17-125, 17-142, 17-149, 17-152, 17-187, 17-191, 17-214, 17-230, 18-189, 18-195, 18-199, 18-203, 18-207

Particle Strengthening (see also "Dispersion Strengthening") 14-15

Particle Transport 12-22, 12-280, 13-3, 13-6, 13-11, 13-18, 13-21, 14-116, 17-75, 17-146, 17-152, 18-224

Particle Velocity 5-62, 5-66

Particle Wetting (see also "Wetting") 1-101, 4-27, 4-32, 4-35, 5-3, 5-18, 5-22, 5-26, 5-87, 5-90, 5-99, 5-104, 5-109, 5-113, 5-121, 5-140, 13-6, 13-21

Passive Cooling (see also "Radiative Cooling") 4-3, 5-41, 8-3, 8-30, 9-5, 9-14, 10-7, 10-12, 12-311, 12-316, 15-53, 17-6, 17-82, 17-90, 17-92, 17-205

Payload Recovery System Failure 5-104, 6-32, 8-22, 9-61, 9-63, 9-153, 11-50, 11-52, 11-89, 12-211, 13-16, 13-18

Payload Survivability 8-99, 9-144, 9-149, 9-153, 10-72, 12-24, 17-133, 17-222, 17-224, 18-121, 18-123

Peltier Pulsing (see also "Interface Demarcation") 14-131, 14-134, 14-141

Peritectic Reaction 14-163, 17-120, 17-125, 17-128

Pharmaceutical Applications (see also "Biotechnology," "Medical Applications," and "Structure Based Drug Design") 1-29, 1-57, 1-65, 1-86, 1-140, 1-144, 1-148, 1-165, 1-170, 8-99, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-65

Pharmaceutical Products 8-99

Phase in addition to the "Phase..." titles below, see "Liquid Phase Epitaxy," "Liquid Phase Sintering," "Minority Phase," "Multiphase Media," "Precipitation of Second Phase," and "Two-Phase System"

Phase Partitioning (see also "Cell Separation" and "Separation of Components") 1-95, 1-101, 1-161, 17-199, 17-226

Phase Segregation (see also "Segregation" and the "Immiscible..." titles) 9-5, 9-9, 17-18

Phase Separation (see also "Dispersion Alloys," "Immiscible Fluids," "Immiscible Alloys," "Separation of Components," and "Systems Exhibiting a Miscibility Gap") 1-95, 1-101, 1-161, 4-9, 4-13, 7-3, 7-5, 7-8, 7-11, 7-24, 7-27, 7-31, 7-33, 7-36, 11-40, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-82, 17-86, 17-90, 17-99, 17-102, 17-105, 17-107, 17-110, 17-116, 17-120, 17-125, 17-128, 17-139, 17-142, 17-146, 17-149, 17-152, 17-155, 17-159, 17-163, 17-169, 17-172, 17-175, 17-178, 17-181, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-214, 17-217, 17-222, 17-224, 17-226, 17-230, 18-178, 18-184

Phase Stability (see also "Fluid Stability," "Stability of Dispersions," and "Stability of Suspensions") 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 7-24, 7-27

Phase Transition (see also "Condensation," "Evaporation," "Vaporization," "Melt and Solidification," and "Vapor/Liquid Transition") 7-3, 7-5, 7-8, 7-11, 7-17, 7-21, 7-24, 7-27, 7-33, 7-36, 12-271, 15-5, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 18-139, 18-144, 18-149, 18-153, 18-159, 18-169, 18-173, 18-178, 18-184

pH Change 1-22, 1-26

pH Level 8-99

Photo see the "photo..." titles in the Sample materials Index

Photoenergetics 16-63

Photographic Difficulties 1-12, 1-105, 2-9, 2-28, 2-41, 2-58, 3-3, 6-3, 6-35, 6-44, 8-7, 9-41, 11-3, 12-3, 12-34, 12-79, 12-96, 12-190, 12-213, 12-222, 12-229, 12-280, 12-316, 12-321, 14-141, 15-5, 15-49, 15-57, 17-226

Physical Chemistry 15-3, 15-5, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 15-53, 15-57, 15-60, 15-63, 15-66, 15-69, 15-72, 15-76, 15-78, 15-81

Physical Vapor Transport (see also "Crystal Growth From Vapor," "Diffusion-Controlled Growth" and "Vapor Deposition") 10-20, 10-24, 10-38, 10-43, 10-57, 10-62

Pictoral X-Ray Enhancement 8-95

Piston System 1-78, 4-55, 4-57, 5-41, 5-99, 5-104, 5-106, 8-52, 8-81, 9-51, 9-54, 12-7, 12-22, 12-24, 12-42, 12-194, 12-256, 12-298, 16-22, 16-25, 16-31, 16-37, 16-42, 17-43, 17-113, 18-189, 18-199, 18-203, 18-207, 18-252

Planar Solidification Interface (see also "Solidification" and the the "Interface..." titles) 2-58, 4-16, 4-19, 5-7, 5-79, 5-82, 5-126, 9-19, 9-25, 9-106, 9-121, 11-21, 14-116, 14-131, 14-159, 17-75, 17-133, 17-136, 17-175

Planet Rotation 12-98, 12-260

Plant Protoplasts see "Protoplasts"

Plasma Spray Coating (see also "Coated Surfaces" (this index) and "plasma spray" in the Container Materials Index) 13-6, 14-97, 14-100, 14-159, 18-77, 18-82, 18-105, 18-108, 18-111, 18-116

Plastics see "Superplastics" (this index) and "plastic" in the Container Materials Index

Plateau Setup (terrestrial experiments) see also "Isodensity Systems" 2-21, 2-28, 2-37

Platelet Habit 6-3, 8-17, 8-34, 8-67, 9-81, 10-7, 10-24, 10-38, 14-52, 14-163

Platelike Structure (see also "Structure") 8-12, 14-49, 14-52, 15-53

Plating (see also "Electroplating" (this index) and "plated cathode" in the Sample Materials Index) 15-10, 15-13, 15-16, 15-19, 15-81, 18-212

Polarization 15-26

Polymer in addition to the titles below, see also "Emulsion Polymerization" (this index) and "poly..." in the Sample Materials Index

Polymer-Gas Foams (see also "Foams" and "Gas") 4-57

Polymerization 1-135, 1-152

Polymer Membranes (see also "Membranes") 1-140, 1-144, 1-148, 1-165, 1-170

Polymers 1-95, 1-101, 17-226, 17-230, 18-252

Polystyrene Latex Microspheres (see also "Monodisperse Latex Particles" and "Spheres" (this index) and "styrene" in the Sample Materials Index) 1-53, 18-189, 18-195, 18-199, 18-203, 18-207

Pores 2-16, 4-19, 5-52, 5-90, 5-95, 5-121, 5-126, 6-35, 9-106, 17-56, 17-59, 17-75

Pore Size (see also "Wide-Pore Systems") 4-19, 4-38, 4-41, 4-57

Porosity (see also "Voids") 1-140, 1-144, 1-148, 1-165, 1-170, 4-16, 4-19, 4-24, 4-38, 4-41, 4-55, 4-57, 5-7, 5-52, 5-113, 5-140, 14-32, 14-35, 14-153, 14-159, 14-163, 17-26, 18-8, 18-12, 18-111

Porous Material 1-48, 5-113, 11-74, 18-144, 18-173, 18-220, 18-224

Porous Plug 12-271, 12-275

Powder in addition to the powder titles below, see also "powder" in the Sample Materials Index

Powder Flow 12-22

Powder Metallurgy (see also "Metal/Metallic" (this index)) 4-3, 4-32, 5-3, 5-14, 5-22, 5-26, 5-35, 5-41, 5-52, 5-72, 5-82, 5-90, 5-95, 5-10613-3, 13-6, 13-18, 13-21, 14-15, 14-105, 17-56, 17-66, 17-69, 17-72, 17-75, 18-82, 18-105, 18-108, 18-220, 18-224

Powders 4-24, 8-3, 9-57, 9-67, 12-22, 13-3, 13-6, 13-18, 13-21, 14-15, 15-10, 15-13, 15-16, 15-19

Precipitation (see also "Immiscible Alloys," "Immiscible Fluids," and "Systems Exhibiting a Miscibility Gap") 5-52, 7-17, 8-3, 8-34, 8-48, 8-63, 8-67, 8-99, 9-81, 9-84, 10-12, 14-15, 14-61, 14-65, 16-8, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-6, 17-38, 17-82, 17-90, 17-92, 17-95, 17-99, 17-110, 17-116, 18-8, 18-111

Precipitation of Second Phase (see also "Immiscible Alloys," "Immiscible Fluids," "Systems Exhibiting a Miscibility Gap" and the "Phase..." titles)

17-43, 17-48, 17-159, 17-163, 17-183, 17-187

Pressure in addition to "Pressure Compensation" below, see "Gas Pressure," and "Hydrostatic Pressure"

Pressure Compensation (see also "Gas Pressure") 16-5, 16-8, 16-10

Pressure Drop 17-102

Processing at High Gravity Levels (see also "Acceleration Effects" and "Centrifuge") 8-7, 14-29, 14-32, 14-42, 14-134

Processing Difficulties <Note: This Key Word was generally used to identify difficulties in fluids and materials processing experiments (even though fluids experiments do not usually involve "processing").> 1-19, 1-48, 1-57, 1-69, 1-73, 1-113, 2-3, 2-16, 2-28, 2-37, 2-46, 2-49, 4-24, 5-14, 5-62, 5-66, 5-130, 5-140, 6-25, 8-88, 9-45, 9-106, 9-125, 10-28, 11-79, 11-82, 12-56, 12-74, 12-77, 12-86, 12-90, 12-98, 12-162, 12-178, 12-187, 12-233, 12-240, 12-246, 12-289, 14-26, 14-69, 14-78, 14-105, 14-120, 14-167, 15-49, 16-15, 16-37, 16-42, 16-53, 17-22, 17-26, 17-30, 17-102, 17-113, 17-125, 17-172, 17-191, 17-196, 18-8, 18-19, 18-58, 18-64, 18-67, 18-82, 18-159, 18-169, 18-189, 18-195, 18-199, 18-224

Processing Time Not As Long As Planned (see also "Incomplete Sample Processing") 8-38, 8-52, 8-58, 14-153, 16-42, 18-212

Propellant Storage (see also "Fuel Tanks" and "Liquid Reservoir") 12-3

Propellant Tanks (see also "Fuel Tanks" and "Fluid Management") 2-13, 12-7, 12-229, 12-252, 12-264, 12-301

Propellant Transfer (see also "Fluid Management," "Fuel Tanks," "Liquid Transfer," and "Mass Transfer") 2-62, 12-7, 12-252, 12-256, 12-264, 18-234

Protein in addition to the "Protein..." titles below, see "protein" in the Sample Materials Index

Protein Crystal Growth (see also "Diffusion-Controlled Growth," "Hanging Drop Method," and the "Crystal..." titles) 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 16-65, 16-70

Protein Macromolecules 1-135, 1-152

Protoplasts (see also "protoplasts" in the Sample Materials Index) 1-105, 1-108, 1-111, 1-113, 1-118, 1-125

Pulling Rate (see also "Solidification Rate" and "Translation Rate") 8-84, 9-69, 9-98

Purity see "Contamination Source," "Impurities," and "Sample Purity"

Q

Quantized Surface Waves (see also "Waves...") 12-275

Quench Process 3-3, 4-9, 4-13, 4-16, 4-19, 4-32, 4-44, 5-48, 5-52, 5-76, 5-79, 7-24, 7-27, 7-36, 8-24, 8-52, 9-14, 9-48, 9-57, 9-67, 9-144, 10-16, 11-13, 11-17, 11-65, 11-79, 11-86, 12-56, 12-71, 12-74, 13-21, 14-29, 14-32, 14-35, 14-38, 14-42, 14-97, 14-159, 17-22, 17-34, 17-38, 17-51, 17-56, 17-107, 17-120, 17-139, 17-142, 17-210, 18-77, 18-86, 18-111, 18-116

R

Radiation <Note: Sometimes "Radiation" was used to indicate "radiative cooling".> 12-13, 12-18, 15-5, 15-60, 15-66, 15-69, 18-135

Radiative Cooling (see also "Passive Cooling") 6-17, 6-28, 6-32, 6-35, 6-39, 6-57, 9-5, 9-9, 14-49, 14-52, 17-163, 17-205

Radiators see "Heat Radiators" and "Heat Pipes"

Radioactive Tracer Diffusion (see also "Diffusion" and "Tracer Particles" (this index) and the "radioactive..." titles in the Sample Materials Index) 11-9, 11-21, 11-37, 18-3, 18-8

Rare Earth Alloys (see also "Alloys") 9-79, 9-81, 17-210

Reactant Solutions (see also "Solutions") 1-135, 2-6, 2-9, 4-24, 4-57, 8-12, 8-17, 8-34, 8-48, 8-95, 12-280, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15

Reaction in addition to the "Reaction..." titles below, see also "Double Replacement Reaction," "Electrochemical Reaction," "Heat of Reaction," "Highly Reactive Materials," "Peritectic Reaction," and "Zhabotinski Reaction" (all in this index) and "reactive" and "reactant" (in the Sample Materials Index)

Reaction Kinetics 4-24, 4-32, 4-35, 4-38, 4-41, 4-51, 4-57, 5-52, 8-7, 10-7, 10-12, 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 12-38, 13-11, 13-21, 16-3, 16-8, 16-10, 16-12, 16-15, 16-22

Reaction of Oil Paints in Space 18-241

Refrigeration (see also "Refrigerator" in the Processing Facility Index) 1-43, 1-69, 1-73, 1-121, 16-48, 16-53, 16-58

Refueling in Orbit (see also "Fluid Management" and "Fuel Tanks") 12-7, 12-252, 12-256, 18-234

Rejection of Solute at Interface 9-41

Reinforced Materials 5-10, 5-22, 5-41, 5-45, 5-99, 5-104, 5-106

Relaxation Processes 15-66

Residual Gravity see "Acceleration Effects"

Resins see "Epoxy Resins" (this index) and "resin" in the Sample Materials Index

Resistance Heating 6-21, 6-25, 6-44, 9-19, 9-25, 9-54, 9-112, 9-144, 12-311, 12-316, 14-46, 14-167, 15-60

Resonant Frequency (see also "Oscillation Frequency") 6-25, 6-28, 6-32, 6-35, 6-39, 6-48, 6-52, 6-54, 12-30, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-226, 12-229, 18-64, 18-67

Reversible Electric Breakdown 1-108, 1-113

Rocket Despin Failure 2-19, 4-16, 5-76, 9-57, 12-113, 12-129, 12-139, 15-30, 17-66, 17-88, 18-86, 18-125

Rocket Failure 5-39, 9-149, 9-153, 11-48, 11-50, 11-52, 11-89, 12-209, 12-211, 13-14, 13-16, 13-18, 15-76, 17-222, 17-224, 18-121, 18-123

Rocket Motion (see also "Acceleration Effects") 1-111, 2-3, 2-62, 4-16, 5-33, 5-39, 5-57, 5-76, 5-99, 5-132, 6-52, 6-57, 7-8, 9-41, 9-54, 9-69, 9-73, 9-104, 9-149, 9-153, 12-3, 12-209, 12-211, 12-240, 13-14, 13-16, 13-18, 15-30, 15-63, 15-72, 17-34, 17-38, 17-66, 17-88, 17-105, 17-222, 17-224, 18-15, 18-71, 18-82, 18-86, 18-231

Rocket Noise 2-62

Rocket Vibration (see also "Acceleration Effects") 2-3, 6-28, 6-57, 10-72, 12-71, 12-213, 16-70, 17-133, 18-199

Rod Structure (see also "Interrod Spacing" and "Structure") 5-82, 14-52, 14-163, 16-10, 17-22, 17-133, 17-136, 17-175

Rotating Atmospheres (see also "Atmospheric Applications") 12-260

Rotating Fluids (see also "Bubble Rotation," "Centrifuge," "Drop Rotation," "Rotation of Payload," "Sample Rotation," "Sloshing," "Spinning Containers," and "Spin-Stabilized Satellites") 2-33, 2-41, 7-8, 8-52, 9-73, 9-76, 9-84, 9-117, 12-30, 12-46, 12-79, 12-82, 12-217, 12-222, 12-229, 12-233, 12-260, 12-301

Rotational Striations (see also "Sample Rotations") 6-13, 8-38, 8-45, 9-76, 9-84, 9-117

Rotational Twinning (see also the "Twin..." titles) 9-5, 9-9

Rotation of Payload (see also "Rotating Fluids" and "Sample Rotation") 9-57, 9-73, 12-71, 12-74, 12-139, 18-15

S

Salt in addition to the "Salt..." titles below, see "Molten Salts" (this index) and "salt," "Na*," and "Na*Cl*" in the Sample Materials Index

Salt Crystals (see also the "Crystal..." titles) 8-30, 15-3

Salt Solution (see also "Solutions") 1-128, 7-17, 7-21, 8-3, 8-30, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-31, 16-63

Sample Deformation (see also "Sample Shrinkage") 2-41, 2-54, 4-3, 9-9, 9-76, 9-84, 9-91, 9-129, 12-79, 12-82, 12-93, 12-98, 13-21, 14-8, 14-11, 14-15, 14-42, 14-69, 14-167, 18-77, 18-82, 18-86, 18-89, 18-92, 18-99, 18-105, 18-111

Sample Detachment from Crucible (see also "Containers," "Crucible Effects," Material Interaction with Containment Facility," and "Non-Wetting of Container") 9-5, 9-9, 9-14, 9-19, 9-25, 9-34, 9-129, 9-138, 9-156, 10-20, 10-24, 11-9, 14-8, 14-11, 14-52, 18-82, 18-102, 18-108

Sample Evaporation (see also "Evaporation" and "Dissolution") 5-62, 9-57, 9-65, 9-67, 11-9, 17-187

Sample Homogeneity (see also "Crystal Homogeneity," "Homogeneity," and "Homogeneous Dispersion") 1-105, 1-152, 6-8, 6-13, 6-25, 6-35, 6-39, 8-7, 8-84, 9-5, 9-9, 9-14, 9-19, 9-25, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-84, 9-88, 9-91, 9-95, 9-98, 9-117, 9-121, 9-129, 9-144, 14-42, 14-109, 14-114, 14-128, 17-18, 17-22, 17-38, 17-43, 17-51, 17-82

Sample Microstructure (see also "Structure") 4-51, 5-7, 5-10, 5-41, 5-45, 5-48, 5-52, 5-57, 5-72, 5-99, 5-106, 6-8, 6-13, 6-25, 6-44, 6-48, 6-52, 6-54, 6-57, 9-125, 10-57, 13-21, 14-3, 14-29, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-61, 14-65, 14-73, 14-82, 14-85, 14-89, 14-93, 14-100, 14-109, 14-128, 14-131, 14-134, 14-145, 14-148, 14-150, 14-153, 14-163, 14-167, 15-81, 17-6, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-75, 17-82, 17-95, 17-102, 17-110, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-175, 17-214, 17-217, 18-3, 18-8, 18-12, 18-19, 18-77, 18-82, 18-111, 18-116

Sample Necking 2-41, 2-54, 9-34, 14-8, 14-11, 14-19, 18-116

Sample Not Processed As Planned <Note: This key word was usually employed to identify experiments which had a sample configured in the payload which was not processed at all, not to identify a sample which was actually processed but with some difficulty.> 1-14, 2-52, 8-55, 9-3, 9-39, 9-101, 9-121, 9-138, 10-3, 10-72, 11-7, 11-24, 11-79, 12-22, 12-38, 12-40, 12-50, 12-172, 12-206, 12-246, 12-252, 12-289, 12-298, 12-301, 12-305, 14-23, 14-76, 14-80, 14-150, 14-163, 15-3, 15-60, 16-15, 16-18, 17-125, 17-159, 17-191, 17-178, 18-43, 18-77, 18-220

Sample Purity (see also "Impurities," "Contamination Source," and "Metal Purification") 1-48, 1-53, 1-65, 1-86, 6-35, 6-39, 6-44, 6-48, 8-67, 8-95, 9-134, 9-138, 9-149, 10-51, 11-74, 12-65, 15-53, 18-67, 18-73

Sample Rotation (see also "Rotating Fluids," "Rotational Striations," and "Spinning Containers") 2-33, 2-41, 6-48, 8-52, 8-84, 8-88, 9-76, 9-84, 9-91, 9-117, 12-30, 12-79, 12-82, 12-93, 12-98, 12-222, 14-3, 14-42, 18-67, 18-215, 18-252

Sample Shrinkage (see also "Sample Deformation" and "Volume Change") 4-3, 5-29, 5-48, 5-90, 6-57, 9-9, 11-9, 13-3, 13-6, 13-21, 14-8, 14-11, 14-35, 14-100, 14-159, 17-43, 17-113, 18-89, 18-92

Sampling of Space Vacuum (see also "Direct Exposure to Space Environment" and "Space Vacuum") 18-238

Satellites see "Spin-Stabilized Satellites"

Saturated Solution (see also "Solutions") 8-27, 8-81, 9-51, 9-54, 14-19, 14-23, 14-26, 15-44, 15-49, 18-3

Saturation (see also "Supersaturation") 4-57, 6-57, 8-30, 8-34, 8-74, 12-60, 12-65

Scanning Ratio Calorimeter (see also "Calorimetric Measurements") 7-11

Schlieren Viewing (see also "Optics Assembly" and "Illumination System") 8-74, 12-105, 12-109, 12-115, 12-123, 12-126, 12-260, 16-5, 16-8, 16-10

Sedimentation (see also "Bubble Sedimentation" and "Stokes Sedimentation") 1-3, 1-6, 1-10, 1-14, 1-17, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-95, 1-101, 1-105, 1-108, 1-113, 1-121, 1-125, 1-128, 1-135, 1-152, 4-51, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-90, 5-95, 5-99, 5-104, 5-106, 5-118, 5-135, 6-48, 6-54, 7-5, 7-8, 7-11, 7-17, 7-21, 7-36, 8-63, 8-67, 8-99, 8-105, 9-19, 9-25, 9-79, 9-81, 13-6, 13-11, 13-21, 14-61, 14-112, 14-116, 14-124, 14-126, 15-10, 15-13, 15-16, 15-19, 15-76, 15-78, 15-81, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63, 17-6, 17-11, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-82, 17-95, 17-99, 17-102, 17-105, 17-110, 17-116, 17-120, 17-125, 17-128, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-222, 17-224, 17-226, 17-230, 18-67, 18-77, 18-189, 18-195, 18-199, 18-203, 18-207, 18-220, 18-224, 18-252

Seed Crystals (see also the "Crystal..." titles) 6-8, 6-13, 8-3, 8-27, 8-38, 8-42, 8-45, 8-52, 8-74, 8-84, 8-88, 9-5, 9-14, 9-27, 9-31, 9-69, 9-95, 9-112, 9-134, 10-3, 10-28, 10-33, 10-43, 10-51, 10-62, 10-65, 14-85, 14-89, 16-37, 16-42, 16-48

Segregation (see also "Axial Segregation," "Macrosegregation," and "Phase Segregation") 4-3, 4-16, 4-24, 5-3, 5-7, 5-10, 5-52, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-121, 5-124, 5-126, 5-140, 6-17, 6-25, 6-35, 6-39, 9-5, 9-9, 9-14, 9-34, 9-76, 9-79, 9-81, 9-91, 9-98, 9-101, 9-106, 9-109, 9-121, 9-144, 9-156, 12-56, 13-6, 13-11, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-55, 14-57, 14-93, 14-159, 17-3, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-38, 17-43, 17-48, 17-51, 17-56, 17-80, 17-82, 17-86, 17-92, 17-95, 17-99, 17-102, 17-120, 17-125, 17-128, 17-139, 17-146, 17-149, 17-152, 17-169, 17-172, 17-181, 17-187, 17-210, 17-214, 17-217, 17-226, 18-12, 18-15, 18-131

Segregation Coefficient 9-34, 9-121

Self-Diffusion (see also "Diffusion", "Double Diffusion," "Interdiffusion," and "Liquid/Liquid Diffusion") 11-9, 11-21, 11-33, 11-37, 11-44, 11-48, 11-50, 11-65, 11-70, 11-74, 11-82

Semiconductor Applications 8-12, 8-17, 8-22, 8-24, 8-38, 8-42, 8-45, 8-84, 9-34, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-84, 9-88, 9-101, 9-104, 9-106, 9-109, 9-129, 9-156, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-65, 10-68, 14-11, 14-15, 14-114, 14-128, 14-131, 14-134

Semiconductor Materials 8-22, 8-24

Semiconductors (see also "Conductivity" and "Conduction") 6-8, 6-13, 8-12, 8-17, 8-22, 8-24, 8-38, 8-42, 8-45, 8-84, 9-19, 9-25, 9-34, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-84, 9-88, 9-129, 9-144, 9-149, 9-153, 10-65, 10-68, 14-128, 14-131, 14-134, 17-18

Semi-Confined Bridgman Growth (see also "Bridgman Technique" and "Directional Solidification") 9-109, 9-156

Semi-Containerless Melt (see also "Containerless Melt," other "Containerless..." titles, and "Crystal Growth from the Melt") 6-8, 6-13, 9-138

Semipermeable Membranes (see also "Films," "Membranes," "Polymer Membranes," and "Thin Film Membranes") 1-165, 1-170, 8-95, 16-25, 16-31, 16-42

Separation of Components (see also "Cell Separation," "Electrophoresis," "Liquid Demixing," "Particle Separation," "Phase Partitioning," "Phase Separation," and the "Immiscible..." titles) 1-3, 1-6, 1-10, 1-17, 1-22, 1-26, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-95, 1-101, 1-161, 1-165, 1-170, 5-3, 5-14, 5-41, 5-90, 5-95, 5-113, 11-40, 11-74, 11-79, 11-82, 12-271, 12-289, 13-11, 13-21, 14-153, 16-65, 17-6, 17-11, 17-14, 17-34, 17-38, 17-43, 17-48, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-82, 17-92, 17-99, 17-102, 17-110, 17-120, 17-125, 17-128, 17-142, 17-149, 17-155, 17-159, 17-163, 17-169, 17-172, 17-178, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-214, 17-222, 17-224, 17-226, 17-230, 18-22, 18-25, 18-58, 18-156, 18-159, 18-250

Shadow Optics (see also "Optic") 11-55

Shear Cell 11-62, 11-82

Shear Forces 1-135, 1-152, 15-10, 15-13, 15-19, 15-81, 18-215

Shear Rate 15-78, 18-189, 18-195, 18-199, 18-203, 18-207

Shells (see also "Spheres" (this index) and "beads" in the Sample Materials Index) 6-39, 12-90, 12-93, 12-260

Shrinkage see "Bubble Shrinkage" and "Sample Shrinkage"

Single Crystals (see also the "Crystal..." titles) 6-8, 6-13, 8-3, 8-7, 8-12, 8-17, 8-22, 8-24, 8-27, 8-38, 8-42, 8-45, 8-48, 8-52, 8-55, 8-58, 8-67, 8-74, 8-84, 8-88, 8-95, 9-5, 9-14, 9-19, 9-25, 9-34, 9-51, 9-54, 9-69, 9-73, 9-79, 9-81, 9-91, 9-95, 9-98, 9-112, 9-117, 9-144, 9-149, 9-153, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-68, 14-163, 16-10, 16-12, 16-15, 16-25, 16-31, 16-63

Single Grain Eutectics (see also "Eutectics" and the "Grain..." titles) 9-27, 9-31

Sintering (see also "Liquid Phase Sintering") 14-15, 14-159

Skin Casting (see also "Casting" and "Coated Surfaces") 5-76, 5-79, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123

Skin Technology (see also "Casting" and "Coated Surfaces") 4-47, 5-76, 5-79, 14-97, 14-100, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-123

Slip Casting (see also "Casting") 18-220, 18-224

Sloshing (Liquid) (see also "Fluid Management," "Partially Filled Containers," and "Rotating Fluids") 2-16, 12-3, 12-7, 12-93, 12-233, 12-256, 12-264, 12-275, 12-301

Slurry Solutions (see also "Solutions") 18-220, 18-224, 18-252

Snow Crystals (see also "Freezing," "Frost," "Ice," and the "Crystal..." titles) 10-28, 10-33

Solar Energy 18-169

Solar Heating 18-162

Solder in addition to the "Solder..." titles below, see also "solder" in the Sample Materials Index

Soldering 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-49, 18-52, 18-58

Soldering-Related Tools 18-49, 18-52, 18-55

Solder Removal 18-43, 18-46

Solid/Gas Dispersion (see also "Gas" and "Dispersion") 5-3

Solid/Gas Interface see "Vapor/Solid Interface"

Solidification see "Bridgman Technique," "Columnar Solidification," "Crystal Growth from the Melt," "Dendritic Solidification," "Directional Solidification," "Free Surface Solidification," "Melt and Solidification," "Planar Solidification Interface," "Quench Process," "Semi-Confined Crystal Growth," "Steady State Solidification," and the "Solidification..." titles (below)

Solidification (Without Melting) 2-58, 9-39

Solidification Front Physics 2-58, 4-16, 4-19, 4-47, 4-51, 5-26, 5-35, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 9-41, 9-45, 9-48, 9-79, 9-81, 9-101, 9-106, 9-109, 9-134, 9-144, 9-156, 10-38, 10-43, 11-86, 11-91, 12-60, 12-65, 14-19, 14-23, 14-26, 14-29, 14-65, 14-85, 14-100, 14-112, 14-116, 14-141, 14-159, 14-163, 17-43, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-139, 17-146, 17-152, 17-169, 17-172, 18-111, 18-116, 18-224

Solidification Rate (see also "Cooling Rate," "Growth Rate," "Pulling Rate," "Quench Process," and "Translation Rate") 4-3, 4-9, 4-47, 5-35, 5-48, 5-52, 5-57, 5-62, 5-66, 5-79, 5-82, 5-121, 5-126, 5-135, 5-140, 9-27, 9-39, 11-86, 14-38, 14-52, 14-65, 14-93, 14-131, 14-134, 17-6, 17-75, 17-82, 17-95, 17-136, 17-163, 17-169, 17-175, 17-183

Solid/Liquid Collision (see also "Collisions") 12-246, 12-249, 12-298, 15-3

Solid/Liquid Dispersion (see also "Dispersion") 5-3, 5-7, 5-10, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-99, 5-104, 5-106, 5-113, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-17, 13-21

Solid/Liquid Interface (see also "Contained Fluids," and the "Interface..." titles) 1-3, 1-6, 1-10, 1-17, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-95, 1-101, 1-128, 2-3, 2-6, 2-9, 2-13, 2-16, 2-21, 2-24, 2-26, 2-28, 2-33, 2-37, 2-41, 2-46, 2-49, 2-52, 2-54, 2-58, 2-62, 2-65, 4-3, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-44, 4-47, 4-51, 4-55, 4-57, 5-3, 5-7, 5-10, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39, 5-41, 5-45, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-90, 5-95, 5-99, 5-104, 5-106, 5-113, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-3, 6-8, 6-

13, 6-17, 6-21, 6-25, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 8-3, 8-7, 8-12, 8-17, 8-22, 8-24, 8-27, 8-30, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-55, 8-58, 8-63, 8-67, 8-74, 8-81, 8-84, 8-88, 8-92, 8-95, 8-99, 8-105, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-39, 9-41, 9-45, 9-48, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 9-95, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-125, 9-129, 9-134, 9-138, 9-144, 9-149, 9-153, 9-156, 11-13, 11-17, 11-21, 11-24, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52, 11-62, 11-65, 11-79, 11-82, 11-86, 11-91, 12-3, 12-7, 12-13, 12-18, 12-24, 12-30, 12-34, 12-38, 12-40, 12-53, 12-56, 12-60, 12-65, 12-105, 12-109, 12-118, 12-121, 12-123, 12-126, 12-131, 12-139, 12-144, 12-149, 12-162, 12-167, 12-175, 12-178, 12-181, 12-194, 12-198, 12-226, 12-229, 12-233, 12-246, 12-249, 12-252, 12-256, 12-264, 12-271, 12-275, 12-280, 12-284, 12-298, 12-301, 13-3, 13-6, 13-11, 13-18, 13-21, 14-3, 14-8, 14-11, 14-15, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-61, 14-65, 14-69, 14-73, 14-80, 14-82, 14-85, 14-89, 14-93, 14-97, 14-100, 14-105, 14-109, 14-112, 14-114, 14-116, 14-124, 14-126, 14-128, 14-131, 14-134, 14-137, 14-141, 14-145, 14-148, 14-150, 14-153, 14-159, 14-163, 14-167, 15-3, 15-5, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-32, 15-36, 15-41, 15-44, 15-49, 15-76, 15-78, 15-81, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-63, 17-3, 17-6, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-146, 17-149, 17-152, 17-159, 17-163, 17-169, 17-172, 17-175, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 17-222, 17-224, 17-230, 18-3, 18-15, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-58, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123, 18-215, 18-234

Solid/Liquid/Gas Dispersion (see also "Dispersion" and "Gas") 4-27, 4-32, 4-35, 4-47, 5-3, 5-7, 5-10, 5-18, 5-22, 5-35, 5-48, 5-52, 5-57, 5-82, 5-90, 5-121, 5-124, 5-126, 5-140, 17-3, 17-59

Solid/Solid Interface 14-120

Solid Solution (see also "Solutions") 9-19, 9-25, 10-16

Solid/Vapor Interface see "Vapor/Solid Interface"

Solubility 12-109, 18-3

Solubility Gap 11-79

Solutal Gradients (see also "Composition Distribution," "Concentration Distribution," and "Density Difference") 4-3, 5-14, 8-27, 8-30, 8-63, 8-67, 8-74, 9-41, 9-48, 9-112, 9-125, 9-129, 11-3, 11-7, 11-58, 11-

82, 12-56, 12-105, 12-109, 12-123, 12-126, 12-222, 12-284, 12-307, 12-321, 14-29, 14-35, 14-93, 14-100, 14-137, 14-141, 14-159, 14-163, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-38, 17-43, 17-48, 17-75, 17-133, 17-136, 17-139, 17-146, 17-152, 17-163, 17-175, 17-205

Solution Calorimetry (see also "Calorimetric Measurements") 14-69, 14-73

Solution Crystal Growth see "Crystal Growth From Solution"

Solutions see (1) (in this index) "Aqueous Solutions," "Compressible Solutions," "Dissolution," "Crystal Growth from Solution," "Electrolyte Solution," "Heat of Solution," "Ionic Solution," "Metallic Solutions," "Reactant Solutions," "Salt Solution," "Saturated Solution," "Slurry Solutions," "Solid Solution," and the "Solution..." titles (below) and (2) "solutions" in the Sample Materials Index

Solution Zone 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 8-92

Solvent 8-12, 8-17, 8-48, 8-63, 8-67, 8-74, 8-88, 10-3, 15-3, 15-53

Soret Diffusion (see also "Diffusion") 14-134, 17-26

Soret Effect 11-62, 11-74, 11-82

Sound Absorption Measurements 15-63, 15-66, 15-69

Sound Attenuation 15-63, 15-66, 15-69

Sound Grid Method 15-63

Sound Lattice Method 15-63, 15-66, 15-69

Sound Waves see "Acoustic Positioning"

Source Material 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-68, 10-72

Space Structures (see also "Structure") 4-9, 4-13, 4-44, 4-57, 5-113, 14-3, 14-153

Space Vacuum (see also "Direct Exposure to Space Environment" and "Sampling of Space Vacuum") 3-3, 10-46, 10-72, 14-3, 18-3, 18-238

Spacing see "Defect Spacing," "Dendritic Arm Spacing," "Fault Spacing," "Inter-Fiber Spacing," and "Interrod Spacing"

Specific Heat see "Isochoric Specific Heat"

Spheres (see also "Polystyrene Latex Microspheres" "Shells," and "Tracer Particles" (this index) and "spheres" in the Sample Materials Index) 6-3, 6-8, 6-13, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-48, 6-52, 6-54, 6-57, 9-84, 9-88, 10-46, 12-3, 12-22, 12-139, 12-181, 13-3, 13-6, 13-18, 13-21, 14-109, 14-120, 18-64, 18-67, 18-71, 18-73, 18-189, 18-195, 18-199, 18-203, 18-207

Spherical Crystals (see also the "Crystal..." titles) 6-8, 6-13, 10-28, 10-33

Sphericity 4-3, 4-29, 4-57, 6-3, 6-8, 6-13, 6-28, 6-39, 9-84, 9-88, 12-90, 12-93, 12-98, 12-103, 12-178, 12-226, 15-5, 15-78, 17-51, 18-207

Spinning Containers (see also "Containers," "Sloshing," "Rotating Fluids," "Rotation of Payload," and "Sample Rotation") 12-229, 12-233, 12-260, 12-301

Spinodal Decomposition (see also "Composition" and "Decomposition") 1-95, 7-5, 7-8, 7-24, 7-27, 7-36, 11-40, 17-51, 17-63

Spin-Stabilized Satellites (see also "Rotating Fluids") 12-301

Spurious Nucleation (see also "Nucleation") 9-9, 10-38, 10-51

Sputter Deposition (see also "Deposition") 10-46

Stability of Dispersions (see also "Dispersion," "Foam Stability," "Fluid Stability," "Phase Stability," and "Stability of Suspensions") 1-14, 2-6, 5-22, 5-26, 5-29, 5-33, 5-35, 5-52, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-90, 5-95, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 17-14, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-178, 17-191, 17-196, 17-199

Stability of Suspensions (see also "Fluid Stability," "Phase Stability," and "Stability of Dispersions") 1-14, 5-22, 5-26, 5-29, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-121, 5-124, 5-126, 5-140

Standing Waves (see also "Waves" and "Acoustic Positioning") 2-33, 12-30, 12-50, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103

Static Column Electrophoresis (see also "Electrophoresis") 1-10, 1-29

Steady-State Solidification (see also "Solidification") 9-5, 9-9, 9-14, 9-69, 9-73, 9-106, 9-134, 14-159

Steady to Oscillatory Convective Transition (see also "Oscillation" and "Time Dependent Thermocapillary Flow") 12-135, 12-139, 12-144, 12-149, 12-157, 12-190, 12-237

Stefan Flow 10-43

Stirring of Components (see also "Liquid Mixing") 4-57, 5-3, 5-7, 5-10, 7-31, 7-36, 8-30, 8-74, 15-10, 15-13, 15-19, 15-78, 15-81, 17-3, 17-178, 17-199, 17-226, 18-189, 18-195, 18-199, 18-203, 18-207

Stoichiometric Compound 17-120, 17-125, 17-128

Stokes Flow 5-62, 5-66, 5-99, 5-106, 6-17, 12-237, 17-34

Stokes Sedimentation (see also "Sedimentation") 5-18, 5-90, 17-63, 17-163, 17-169, 17-172

Strain (see also "Crystalline Strain") 6-8

Stress 8-84, 10-51, 18-77

Striations (see also "Rotational Striations") 6-13, 8-38, 8-42, 8-45, 9-69, 9-73, 9-76, 9-84, 9-88, 9-91, 9-98, 9-106, 9-109, 9-117, 9-121, 9-125, 9-149, 9-153, 9-156

Structural Transformation 15-63, 15-66, 15-69

Structure see "Biological Structures," "Collagen Structures," "Crystalline Structure," "Dendritic Structure," "Fan-Like Structure," "Fibrin Structures," "Film Microstructure," "Grain Structure," "Lamellar Structure," "Platelike Structure," "Rod Structure," "Sample Microstructure," Space Structures," and "Structural Transformation"

Structure Based Drug Design (see also "Pharmaceutical Applications") 1-152, 16-5, 16-8, 16-10, 16-12, 16-15, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Sublimation 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-65, 10-68, 10-72

Substrates 8-22, 8-24, 9-51, 9-54, 10-46, 10-57, 10-62, 10-68, 10-72, 15-10, 15-13, 15-16, 15-19, 15-41, 15-49, 18-15

Superconductivity (see also "Conductivity") 8-55, 8-58, 15-10, 15-13, 15-16, 15-19, 17-6, 17-169, 17-172, 17-214

Superconductors (see also "Conductivity" and "Conduction") 14-11, 14-15, 17-34, 17-38, 17-43, 17-214

Supercooling 4-3, 6-3, 6-8, 6-13, 6-21, 9-19, 9-25, 9-54, 14-19, 14-38, 14-42, 17-163

Superfluids 12-271, 12-275

Superheating 4-57, 6-17, 9-41, 15-36, 15-41, 17-22, 18-116

Superplastics 14-38, 14-42, 14-153

Supersaturation (see also "Saturation") 4-29, 8-3, 8-99, 9-54, 10-28, 10-33, 10-38, 10-43, 10-51, 10-68, 13-11, 15-24

Surface in addition to the "Surface..." titles below, see also "Free Surface"

Surface Charge (see also "Charged Particles") 1-3, 1-6, 1-10, 1-17, 1-22, 1-29, 1-35, 1-41, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 12-46, 12-175

Surface Energy (see also "Interfacial Energy") 4-3, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-90, 5-106, 12-98, 12-103, 13-6, 14-120, 15-5, 17-14, 17-34, 17-38, 17-43, 17-48, 17-51, 17-59, 17-75, 17-169, 17-172, 18-3

Surface Morphology (see also "Crystal Morphology") 4-3, 6-3, 6-8, 6-13, 6-17, 6-28, 6-35, 6-39, 6-54, 6-57, 8-3, 8-22, 8-24, 8-27, 8-34, 8-38, 8-42, 8-45, 8-52, 8-74, 8-84, 8-88, 8-92, 8-95, 8-99, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-41, 9-45, 9-48, 9-57, 9-61, 9-63, 9-65, 9-67, 9-81, 9-84, 9-88, 9-98, 9-121, 9-129, 9-138, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 11-9, 13-21, 14-3, 14-8, 14-11, 14-29, 14-32, 14-35, 14-49, 14-52, 14-89, 14-153, 14-163, 15-10, 15-13, 15-16, 15-19, 15-53, 15-81, 18-241

Surface Roughness 6-17, 15-44, 18-15, 18-241

Surface Tension (see also "Interfacial Tension") 2-3, 2-6, 2-9, 2-13, 2-16, 2-21, 2-24, 2-26, 2-28, 2-37, 2-46, 2-49, 2-52, 2-54, 2-58, 2-62, 4-3, 4-27, 4-29, 4-32, 4-35, 4-44, 4-47, 4-55, 4-57, 5-48, 5-135, 6-3, 6-8, 6-13, 6-39, 8-24, 9-9, 9-14, 9-19, 9-25, 9-76, 9-84, 9-88, 9-91, 9-98, 9-101, 9-104, 9-106, 9-109, 9-112, 9-117, 9-121, 9-138, 9-144, 9-149, 9-153, 9-156, 11-55, 11-58, 11-95, 12-3, 12-7, 12-13, 12-18, 12-24, 12-27, 12-30, 12-34, 12-40, 12-46, 12-53, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-129, 12-131, 12-167, 12-172, 12-175, 12-178, 12-181, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-209, 12-211, 12-213, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-246, 12-249, 12-252, 12-256, 12-264, 12-275, 12-284, 12-289, 12-294, 12-298, 12-301, 12-307, 12-311, 12-316, 12-321, 13-3, 14-3, 14-8, 14-11, 14-97, 14-109, 14-114, 15-5, 17-14, 17-34, 17-38, 17-43, 17-48, 17-51, 17-75, 17-92, 17-139, 17-142, 17-169, 17-172, 17-199, 17-205, 18-3, 18-8, 18-12, 18-15, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-49, 18-52, 18-58, 18-82, 18-92, 18-102, 18-108, 18-116, 18-139, 18-144, 18-153, 18-156, 18-159, 18-169, 18-173, 18-178, 18-184, 18-215, 18-234

Surface Tension-Driven Convection (see also "Convection at the Interface," "Marangoni Convection," and "Thermocapillary Convection") 4-47, 8-7, 9-34, 9-76, 9-84, 9-88, 9-91, 9-98, 9-106, 12-13, 12-18, 12-56, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-184, 12-187, 12-190, 12-198, 12-201, 12-206, 12-209, 12-211, 12-217, 12-222, 12-237, 12-240, 12-243, 12-284, 12-321, 13-6, 14-97, 14-100, 14-114, 14-116, 15-22, 15-32, 15-36, 15-41, 15-44, 15-49, 17-34, 17-38, 17-43, 17-48, 17-163, 18-111

Surface Tension Determination 12-298

Surface Tension Gradients (see also "Surface Tension-Driven Convection," "Marangoni Convection," and "Thermocapillary Convection") 2-65, 4-47, 12-105, 12-113, 12-115, 12-118, 12-123, 12-126, 12-139, 12-144, 12-149, 12-153, 12-157, 12-194, 12-198, 12-201, 12-307, 12-321, 17-38, 17-43, 17-48, 17-59, 17-75

Surface Tension Minimum 12-53, 12-194, 12-198, 12-201, 12-206, 12-209, 12-211, 18-34

Surfactants 4-57, 12-18, 12-60, 12-65, 15-81, 17-199

Suspension (see also "Dispersion" and "Stability of Suspension") 15-53, 18-220, 18-224

Suspension of Particles (see also "Dispersion" and "Particle Dispersion") 1-3, 1-6, 1-10, 1-14, 1-17, 1-22, 1-26, 1-29, 1-78, 1-128, 5-22, 5-26, 5-29, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-109, 5-121, 5-124, 5-126, 5-140, 15-3, 15-10, 15-13, 15-16, 15-19, 15-57, 15-76, 15-78, 15-81, 18-189, 18-195, 18-199, 18-203, 18-207, 18-252

Systems Exhibiting a Miscibility Gap (see also "Dispersion Alloys," "Immiscible Alloys," "Immiscible Fluids," "Metallic Matrix," "Minority Phase," "Phase Separation," and "Separation of Components") 17-3, 17-6, 17-11, 17-14, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-88, 17-90, 17-92, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-146, 17-149, 17-152, 17-155, 17-159, 17-163, 17-169, 17-172, 17-175, 17-178, 17-181, 17-183, 17-187, 17-191, 17-196, 17-199, 17-205, 17-210, 17-214, 17-217, 17-222, 17-224, 17-226, 17-230

T

Technological Experiments 18-3, 18-8, 18-12, 18-15, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55, 18-58, 18-61, 18-64, 18-67, 18-71, 18-73, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123, 18-125, 18-127, 18-129, 18-131, 18-135, 18-139, 18-144, 18-149, 18-153, 18-156, 18-159, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184, 18-189, 18-195, 18-199, 18-203, 18-207, 18-212, 18-215, 18-220, 18-224, 18-228, 18-231, 18-234, 18-238, 18-241, 18-244, 18-247, 18-250, 18-252

Tensile Strength (see also "Material Strength") 5-22, 5-109, 14-38, 14-42

Terminal Velocity 12-298

Ternary Systems (see also "Alloys" and "Composites") 4-27, 4-32, 4-35, 4-47, 4-55, 5-3, 5-7, 5-10, 5-22, 5-69, 5-72, 5-90, 5-99, 5-104, 5-106, 6-13, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 8-7, 8-12, 8-17, 8-22, 8-24, 8-38, 8-42, 8-45, 8-84, 8-88, 8-92, 9-5, 9-9, 9-19, 9-25, 9-57, 9-61, 9-63, 9-65, 9-67, 9-129, 9-134, 10-16, 12-60, 12-65, 13-6, 13-11, 13-18, 14-15, 14-73, 14-167, 17-6, 17-11, 17-22, 17-99, 17-183, 17-187, 17-199, 17-214, 17-222, 17-224, 18-3, 18-8, 18-12, 18-15, 18-19, 18-67, 18-71, 18-73, 18-99, 18-111

Thermal Conductivity Measurements (see also "Conductivity") 5-79, 15-72, 17-155

Thermal Control (see also "Heat Pipes," "Heat Radiators," and other "Heat..." titles) 9-54, 9-65, 12-271, 12-275, 16-18, 18-139, 18-144, 18-149, 18-153, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184, 18-189, 18-195

Thermal Convection (see also "Convection," "Buoyancy-Driven Convection," "Thermosolutal Convection," and "Thermocapillary Convection") 1-6, 1-10, 1-29, 1-35, 1-41, 1-105, 1-108, 1-113, 5-3, 5-14, 5-22, 5-41, 6-25, 10-28, 11-86, 12-13, 12-18, 12-260, 14-8, 14-11, 14-124

Thermal Diffusion (see also "Diffusion" and "Heat Conduction") 7-5, 7-8, 7-11, 10-68, 11-62, 11-74, 11-82, 12-13, 12-18

Thermal Distribution 17-155, 18-131, 18-135

Thermal Environment More Extreme Than Predicted 1-35, 1-101, 1-113, 2-3, 5-18, 5-48, 5-72, 5-99, 5-109, 5-113, 6-39, 6-57, 8-12, 8-24, 8-27, 8-58, 9-48, 9-138, 10-28, 10-68, 11-24, 11-28, 11-40, 12-24, 12-56, 12-246, 12-275, 15-22, 16-31, 16-37, 16-42, 17-26, 17-43, 17-155, 17-187, 17-191, 17-196, 18-43, 18-58, 18-135, 18-224

Thermal Equilibrium 7-5, 7-8, 7-11, 7-24, 8-74, 8-88, 10-68, 12-42, 12-149, 12-153, 12-157, 12-162, 12-167, 18-12

Thermal Expansion 7-33, 14-116, 18-77, 18-82

Thermal Fining 12-167

Thermal Gradient 1-22, 1-26, 1-48, 2-58, 4-3, 4-19, 4-51, 5-14, 5-26, 5-29, 5-35, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-90, 5-118, 5-121, 5-126, 5-130, 5-132, 5-135, 5-140, 6-3, 6-8, 6-13, 6-57, 7-33, 8-27, 8-30, 8-74, 9-5, 9-9, 9-19, 9-25, 9-27, 9-31, 9-34, 9-48, 9-69, 9-73, 9-79, 9-84, 9-88, 9-95, 9-109, 9-112, 9-125, 9-129, 9-134, 9-144, 9-149, 9-153, 9-156, 10-7, 10-12, 10-16, 10-24, 10-38, 10-43, 10-51, 10-57, 10-62, 10-68, 11-40, 11-62, 11-65, 11-74, 11-82, 11-86, 12-13, 12-18, 12-56, 12-60, 12-65, 12-118, 12-121, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-167, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-217, 12-222, 12-237, 12-240, 12-243, 12-260, 12-280, 12-289, 12-294, 12-305, 12-311, 12-316, 14-8, 14-11, 14-19, 14-23, 14-26, 14-29, 14-35, 14-46, 14-61, 14-65, 14-85, 14-89, 14-93, 14-97, 14-100, 14-105, 14-116, 14-128, 14-131, 14-134, 14-137, 14-141, 14-159, 14-163, 16-12, 16-15, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-43, 17-72, 17-75, 17-80, 17-95, 17-99, 17-102, 17-105, 17-113, 17-116, 17-120, 17-133, 17-136, 17-139, 17-142, 17-146, 17-152, 17-155, 17-175, 17-183, 17-187, 17-205, 17-210, 18-73, 18-77, 18-82, 18-86, 18-102, 18-105, 18-108, 18-111, 18-116, 18-203

Thermal Oscillations (see also "Oscillation") 10-51, 12-144, 12-149, 12-153, 12-157, 12-280, 15-72, 17-128

Thermal Radiation see "Radiation"

Thermal Soak 4-27, 4-29, 5-22, 5-29, 5-41, 5-48, 5-52, 5-90, 5-95, 5-99, 5-104, 5-106, 6-28, 8-52, 9-5, 9-9, 9-14, 9-19, 9-25, 9-34, 9-57, 9-67, 11-

9, 11-40, 11-62, 11-65, 11-79, 11-82, 14-8, 14-11, 14-29, 14-35, 14-85, 17-6, 17-18, 17-22, 17-26, 17-43, 17-48, 17-59, 17-63, 17-66, 17-69, 17-183, 17-191

Thermoacoustic Effects 5-48

Thermocapillary Bubble Motion see "Bubble Migration," "Bubble Motion," "Bubble Transport," "Marangoni Movement (Migration) of Bubbles" and "Thermomigration"

Thermocapillary Convection (see also "Capillary Flow," "Convection," "Marangoni Convection," "Surface Tension-Driven Convection," and "Time Dependent Thermocapillary Flow") 4-29, 9-76, 9-91, 9-98, 9-112, 9-117, 9-121, 9-149, 9-153, 9-156, 12-13, 12-65, 12-109, 12-118, 12-121, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-206, 12-217, 12-222, 12-237, 12-240, 12-243, 12-289, 12-294, 12-311, 12-316, 14-114, 14-116, 14-137, 15-22, 15-32, 15-36, 15-41, 15-44, 15-49, 17-34, 17-38, 17-43, 17-48, 17-139, 17-142, 17-146, 17-205, 18-12

Thermocapillary Droplet Motion see "Drop" and "Marangoni Movement of Droplets"

Thermocapillary Flow (see also "Thermocapillary Convection" and "Time Dependent Thermocapillary Flow") 9-76, 9-84, 9-88, 9-91, 12-167, 17-142, 18-3, 18-8, 18-12, 18-15, 18-19

Thermomigration (see also "Marangoni Movement (Migration) of Bubbles," "Marangoni Movement of Droplets" and possibly "Particle Migration") 5-90, 5-95, 11-62, 11-82, 12-60, 14-89, 17-43, 17-48, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-95, 17-99, 17-102, 17-110, 17-116

Thermopotential Measurements 11-74

Thermosolutal Convection (see also "Convection") 8-27, 8-30, 8-52, 8-74, 8-88, 9-39, 9-91, 9-125, 9-129, 10-65, 10-68, 11-86, 12-71, 12-74, 12-222, 14-29, 14-35, 14-61, 14-93, 14-137, 14-141, 14-159, 14-163, 17-22, 17-26, 17-30, 17-43, 17-133, 17-136, 17-175, 17-205

Thin Film Membranes (see also "Films" and "Membranes") 1-140, 1-144, 1-148, 1-165, 1-170

Thin Films (see also "Films" and "Membranes") 2-9, 2-16, 2-37, 2-41, 4-13, 4-47, 5-76, 5-79, 5-121, 6-57, 8-24, 9-9, 9-51, 9-54, 9-84, 9-112, 9-117, 9-121, 9-138, 10-46, 10-57, 10-62, 10-65, 10-68, 10-72, 12-34, 12-40, 12-162, 12-275, 12-284, 12-307, 13-6, 14-69, 14-97, 14-100, 14-159, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-41, 15-44, 15-49, 15-81, 17-56, 17-181, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123, 18-215

Three-Dimensional Crystalline Structure (see also the "Crystal..." titles and "Structure Based Drug Design") 8-63, 8-67, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 16-63

Time Dependent Thermocapillary Flow (see also "Marangoni Convection," "Steady to Oscillatory Convective Transition") 9-76, 9-84, 9-88, 9-91, 9-117, 9-121, 9-149, 9-153, 12-135, 12-139, 12-144, 12-149, 12-153, 12-157, 12-190, 12-194, 12-237

Tracer Material 11-70, 18-3, 18-8, 18-12

Tracer Particles (see also the "Particle..." titles and "Radioactive Tracer Diffusion") 2-21, 2-28, 2-33, 2-58, 11-9, 11-21, 11-37, 11-44, 11-65, 12-13, 12-18, 12-30, 12-98, 12-131, 12-135, 12-139, 12-162, 12-184, 12-187, 12-190, 12-194, 12-198, 12-201, 12-217, 12-222, 12-229, 12-233, 12-237, 12-243, 12-284, 12-307, 12-321, 18-3, 18-8, 18-12

Transient-Hot-Wire Technique see "Hot-Wire Technique"

Transistors 18-247

Translation Rate (see also "Cooling Rate," "Furnace Translation," "Growth Rate," "Pulling Rate," and "Solidification Rate") 5-126, 8-52, 8-88, 9-76, 9-81, 9-84, 9-91, 9-112, 9-117, 10-65, 14-112, 14-131, 17-26, 17-30, 17-175, 18-111, 18-116

Transparent Liquids (refer to the "Sample Materials" Index for further listings (including "oil," "paraffin" and "silicone oil")) 5-57, 5-62, 5-66, 8-74, 9-41, 12-139, 12-144, 12-149, 12-153, 12-157, 12-162, 12-190, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-256, 12-260, 12-284, 12-289, 12-294, 14-116, 14-137, 14-141, 15-5, 15-22, 15-24, 15-32, 15-36, 15-41, 15-44, 15-49, 15-72, 17-146, 17-152, 17-178, 17-199, 17-205, 17-226

Transport Agent 10-7, 10-12, 10-16, 10-68

Transport Phenomena 11-74

Travelling Heater Method 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 8-92

Tribology 18-215

Turbine Blade Applications 5-99, 5-104, 5-106, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-99, 18-102, 18-105, 18-108, 18-111

Turbulent Flow 7-36, 8-63, 9-76, 9-91, 9-117, 10-65, 11-95, 12-135, 12-237, 12-260, 16-3, 18-3

Twin Boundary 9-14, 9-19, 9-25

Twinning (see also "Rotational Twinning") 8-7, 8-17

Two-Phase System (see also "Dispersion," "Dispersion Alloys," "Immiscible Alloys," "Immiscible "Liquids," "Multiphase Media," "Systems Exhibiting a Miscibility Gap," and the "Phase..." titles) 1-95, 1-101, 1-161, 4-27, 4-29, 4-44, 4-47, 4-51, 4-55, 7-5, 7-8, 7-11, 7-17, 7-21, 7-24, 7-27, 7-31, 7-33, 7-36, 9-19, 9-25, 9-27, 9-31, 12-271, 12-289, 12-294, 13-3, 13-21, 17-26, 17-51, 17-63, 17-69, 17-72, 17-82, 17-86, 17-199, 17-230, 18-215

U

Ultrasonic Absorption 15-63, 15-66, 15-69

Ultrasonic Mixing (see also "Acoustic Mixing" and "Liquid Mixing") 7-24, 7-27, 15-78

Ultrasonic Waves 15-63, 15-66, 15-69

Undercooling 2-58, 6-3, 6-25, 6-48, 6-52, 6-54, 6-57, 8-74, 14-124, 14-126, 14-137, 14-163, 17-51, 17-75, 17-136, 17-175, 18-67, 18-73

V

Vacuolated Protoplasts see "Protoplasts"

Vacuum (see also "Sampling of Space Vacuum," "Space Vacuum," and other "Vacuum..." titles (below)) 4-3, 4-9, 4-51, 5-106, 8-27, 8-52, 9-5, 9-14, 9-19, 9-25, 9-34, 9-129, 9-144, 10-12, 10-46, 10-57, 10-72, 11-17, 11-65, 12-86, 12-256, 12-275, 12-301, 14-3, 14-42, 14-100, 14-120, 14-167, 15-57, 15-60, 18-8, 18-12, 18-34, 18-55, 18-82, 18-135, 18-189, 18-195, 18-199, 18-203, 18-207, 18-212, 18-238

Vacuum Brazing see "Brazing"

Vacuum Film Deposition (see also "Deposition" and "Films") 10-46, 10-72

Van der Waals Forces 5-82, 12-275

Vapor Crystal Growth see "Crystal Growth From Vapor"

Vapor Deposition (see also "Crystal Growth from Vapor" and "Deposition") 5-99, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-65, 10-68, 10-72, 18-15, 18-31, 18-135

Vapor Diffusion Method (see also "Crystal Growth from Vapor" and "Diffusion") 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Vapor Emulsion see "Emulsion"

Vapor Pressure see "Gas Pressure"

Vaporization (see also "Evaporation" and "Phase Transition") 4-51, 6-32, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-65, 10-68, 10-72, 12-79, 14-163, 15-36, 15-41, 15-44, 15-49, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-

139, 18-144, 18-149, 18-153, 18-159, 18-166, 18-173, 18-178, 18-184

Vapor/Liquid Transition (see also "Phase Transition," "Condensation," "Evaporation," and "Vaporization") 7-5, 7-8, 7-11, 7-17, 7-21, 7-33

Vapor/Solid Interface (see also "Bubble Dispersion," "Composites with Gases" "Crystal Growth from Vapor," and the "Interface..." titles) 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-46, 10-51, 10-57, 10-62, 10-65, 10-68, 10-72, 12-13, 12-18

Vapor Transport (see also "Crystal Growth From Vapor" and "Diffusion-Controlled Growth") 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-28, 10-33, 10-38, 10-43, 10-51, 10-57, 10-62, 10-65, 10-68, 18-139, 18-144, 18-149, 18-153

Vapor Ventilation see "Ventilation"

Vehicle Re-entry Forces/Vibration 2-58, 8-3, 8-63, 8-67, 8-99, 9-57, 9-69, 12-3, 12-105, 12-109, 14-132, 16-25, 16-70, 17-38, 18-82

Velocity see "Drop Velocity," "Flow Velocity," "Impact Velocity," and "Terminal Velocity"

Ventilation (see also "Gas-Free Liquid Expulsion") 11-55, 11-58, 12-271

Vibration see "Accelerations/Vibrations Produced by Onboard Equipment," "Drop Vibration," "Liquid Dynamic Response," "Liquid Vibration," "Meniscus Vibration," and the "Vibration..." titles (below)

Vibration Damping see "Fluid Motion Damping"

Vibration Isolation Systems (see also "Fluid Motion Damping") 1-121, 18-228

Virus see "virus" in the Sample Materials Index

Viscoelastic Bodies 12-77

Viscosity 1-95, 1-101, 2-28, 5-48, 5-135, 6-21, 6-28, 12-30, 12-71, 12-77, 12-98, 12-131, 12-213, 12-217, 12-229, 12-233, 12-275, 12-294, 15-26, 15-63, 15-66, 15-69, 17-183, 17-187, 17-199, 17-210, 18-189, 18-199, 18-203, 18-207

Voids (see also "Macrovoids" and "Porosity") 4-13, 4-51, 5-35, 5-41, 5-48, 5-99, 5-104, 5-106, 6-3, 9-19, 9-25, 9-57, 9-67, 9-129, 12-60, 12-65, 17-217, 18-89

Volume Change (see also "Sample Deformation" and "Volume Expansion") 5-90, 6-8, 8-84, 9-9, 9-19, 9-25, 9-34, 9-76, 9-129, 9-138, 9-144, 12-56, 14-100, 14-128, 14-131, 14-134, 14-159, 17-59, 17-217, 18-99, 18-189, 18-199, 18-203, 18-207, 18-212

Volume Compensation 5-140, 8-52, 8-84, 14-85, 14-89, 14-128, 14-131, 14-134, 14-159, 15-32, 15-36, 15-41, 15-44, 15-49, 17-163, 17-191, 18-99, 18-105, 18-108, 18-111, 18-189, 18-199, 18-203, 18-207, 18-212

Volume Expansion (see also "Volume Change") 4-47, 5-14, 5-99, 5-140, 6-8, 9-9, 9-76, 9-138, 11-74, 12-167, 14-97, 14-116, 14-167, 15-32, 15-36, 15-41, 15-44, 15-49, 17-163, 17-191, 18-77, 18-82, 18-89, 18-92, 18-105, 18-116

Volume Retention 18-102, 18-108, 18-111

W

Wall Effect (see also "Electroosmosis") 1-3, 1-6, 1-10, 1-17, 1-22, 1-26, 1-35, 1-61, 2-21, 11-3, 11-7, 11-65, 12-42, 15-66, 15-69

Water see "water" in the Sample Materials Index

Water Spray 3-3

Wave Propagation 12-24

Waves see "Capillary Waves," "Chemical Waves," "Quantized Surface Waves," "Standing Waves," "Wave Propagation," "Ultrasonic Waves," and the "Acoustic..." and "Sound..." titles

Welding (see also "Arc Welding") 4-19, 14-3, 18-28, 18-238

Wetting (in addition to the "Wetting..." titles below, see (1) "Particle Wetting," "Non-Wetting of Container," "Coated Surfaces," "Contact Angle," "Crucible Effects," "Free Surface Elimination," "Liquid Spreading," and "Sample Detachment from Crucible" (in this index) and (2) "coated materials," "coating" and "wettability" in the Container Materials Index) 1-95, 1-101, 1-161, 2-13, 2-16, 2-19, 2-21, 2-24, 2-28, 2-33, 2-37, 2-46, 2-49, 2-52, 2-54, 2-65, 4-3, 4-24, 4-51, 5-3, 5-14, 5-18, 5-22, 5-26, 5-48, 5-90, 5-95, 5-99, 5-109, 5-140, 6-28, 6-32, 7-31, 8-12, 8-24, 9-5, 9-9, 9-14, 9-19, 9-25, 9-57, 9-67, 9-84, 9-101, 9-106, 9-109, 9-134, 9-138, 9-144, 9-156, 11-55, 11-58, 11-74, 12-3, 12-7, 12-18, 12-30, 12-86, 12-90, 12-109, 12-139, 12-144, 12-149, 12-194, 12-256, 13-21, 14-8, 14-11, 14-137, 17-22, 17-26, 17-38, 17-59, 17-63, 17-69, 17-72, 17-75, 17-92, 17-139, 17-142, 17-163, 17-181, 17-199, 17-205, 17-217, 17-226, 18-3, 18-8, 18-12, 18-15, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-49, 18-52, 18-58, 18-77, 18-82, 18-86, 18-89, 18-92, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-215

Wetting Agent 2-3

Wetting Kinetics 2-16, 2-19, 2-21, 2-24, 2-28, 2-33, 2-37, 2-41, 2-54, 12-175, 12-178, 12-181, 12-184, 12-217, 18-15, 18-215

Wetting of Container (see also "Containers," "Crucible Effects," and "Non-Wetting of Container") 1-95, 1-101, 2-3, 2-21, 2-24, 2-46, 2-49, 4-24, 5-14, 5-18, 5-140, 7-27, 9-5, 9-57, 9-67, 9-106, 9-134, 12-3, 12-13, 12-24, 12-53, 12-56, 12-105, 12-109, 12-115, 12-162, 12-256, 13-21, 14-159, 17-22, 17-59, 17-75, 17-92, 17-139, 17-181, 17-210, 17-226, 18-15, 18-82, 18-111

Whiskers (see also "whiskers" in the Sample Materials Index) 5-7, 5-41, 5-45, 5-99, 5-104

White Cells (see also "Biological Cells") 1-86, 1-90

Wicking (see also "wicks" in the Sample Materials Index) 2-3, 2-13, 2-62, 18-144, 18-149, 18-153, 18-156, 18-159, 18-173, 18-178, 18-184

Wide-Pore Systems (see also the "Pore..." titles) 2-16

X

X-Ray Detectors 10-51

X-Ray Enhancement (Pictoral) see "Pictoral X-Ray Enhancement"

X-Ray of Liquid Metal in Space (see also "Metal/Metallic" (this index)) 17-159, 17-163

Y

Yeast see "yeast" in the Sample Materials Index

Z

Zhabotinski Reaction 12-280

Zone-Refining 14-112

Index B: Investigator Index

Investigators Index

A

Aalto, S. 15-72
Abdalla, K. L. 12-7
Abi-Akar, H. 15-81
Adair, H. L. 12-56
Adkins, N.J.E. 5-135
Aernoudt, E. 4-3
Agawa, T. 10-28, 10-33
Ahlborn, H. 6-25, 17-51, 17-183, 17-187
Alabama A&M University 14-150, 14-153
Alabama Space and Rocket Center 8-55, 8-58, 14-150, 14-153
Alario, J. P. 18-149
Alford, G. C. 18-22, 18-25
Allen, R. E. 1-29
Alltech Associates Inc. 18-250
Alyward, J. 8-27
American Institute of Aeronautics and Astronautics 16-18, 18-25, 18-156
Amidon, J. M. 14-109
Anderson, J. 18-250
Ang, C. Y. 5-48, 5-52, 17-18
Arkens, O. 4-3
Asahi National Broadcasting Company, Ltd. 12-246, 12-249, 14-145, 14-148
Asar, H. K. 17-199
Ausprunk, D. 1-121
Authier, A. 8-34
Ayhan, M. 17-222, 17-224

B

Bach, H. 17-210
Bannister, T. 8-3, 11-3, 11-7, 12-13, 12-18, 12-30, 12-53
Barklage-Hilgefort, H. J. 11-13
Barlow, G. 1-10, 1-29, 1-73
Barmatz, M. 6-44
Bathke, W. 18-8
Baudry, P. 7-31
Bechler, B. 1-90
Beier, W. 11-17, 11-52
Bellows, A. H. 18-131
Bennit, C. 17-178
Benz, K. W. 8-38, 8-42, 8-45
Bergman, A. 17-90, 17-92, 17-95
Bert, J. 11-74
Bethin, J. 17-175
Bewersdorff, A. 12-280
Beysens, D. 7-24, 7-27, 7-31
Bieber, J. 12-301
Bier, M. 1-17, 1-22, 1-26, 1-29
Bigazzi, P. E. 1-29
Bijovet, J. 18-231
Billia, B. 9-125
Birman, B. 12-298, 12-301, 15-60
Bisch, C. 12-226
Bollong, B. 9-144
Bourgeois, S. V. 12-46, 12-53
Boyd, W. C. 18-234
Braedt, M. 11-17, 11-21, 11-24
Braetsch, V. 11-24, 11-33, 11-37, 11-40, 11-44
Brisson, P. 10-38, 10-43
Brooks, D. E. 1-95, 1-101
Bruce, L. C. 14-167
Brückner, R. 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126
Bruder, M. 10-65
Büchner, K. H. 1-108, 1-113
Buckbee, E. O. 8-55, 8-58, 14-150, 14-153
Bugg, C. E. 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Burgess, R. 16-65
Burroughs Wellcome Company 16-25, 16-31, 16-37, 16-42
Busboso, E. 15-57, 18-228

C

Cadoret, R. 10-38, 10-43
Calhoun, L. D. II 18-162
Camel, D. 9-125, 9-156, 14-93
Carlberg, T. 9-98, 9-101, 9-104, 9-106, 9-109, 14-114, 17-82, 18-19
Carruthers, J. 12-30
Carter, D. 16-48, 16-53, 16-58
Casarez, C. 18-244
Cassanto, J. 16-70
Caton, P. D. 5-118, 17-169, 17-172
Cavoli, S. R. 8-95
Chalmers Aerospace Club 15-72
Chang, C. E. 9-19, 9-25
Chao, F. 1-121
Chazanoff, S. 12-275
Chong, D. 14-167
Christ, H. 12-121, 12-123, 12-126
Chun, Ch.-H. 12-129, 12-131, 12-135
Cigas, T. 8-27
Clyne, D. 5-118, 17-169
Clyne, T. W. 5-130, 5-132, 5-135
Cogoli, A. 1-78, 1-86, 1-90
Collins, D. J. 12-275
Compston, B. 1-144
Concus, P. 17-226
Converse, V. W. 18-61
Cook, E. 8-67, 10-57, 10-62
Cook, W. 16-53
Cowgill, P. J. 12-275
Cröll, A. 9-117, 9-121
Croonquist, A. P. 12-93
Crouch, R. K. 9-129
Cutting, J. F. 8-67

D

Dalley, A. M. 5-109
Darbro, W. 12-34
Da Riva, I. 2-28, 2-33
Davidson, M. C. 10-3
Day, D. E. 6-35, 6-39
Debe, M. 10-57, 10-62
Debnam, W. J. 9-129
de Goer, J. 14-82, 14-85
DeLucas, L. J. 16-48, 16-58
Deruyttere, A. 4-3, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-39
Deschenes, J.-F. 10-72
Dian, R. 8-52, 10-65
Dietl, V. 17-51
Dijkstra, H. A. 12-284, 12-307
Doremus, R. 6-44
Dornier System GmbH 18-135
Drake, M. C. 8-67
Drinkenburg, A.A.H. 12-284
Duffar, T. 9-134
Dunlap, B. 12-24, 12-46
Dupuy, J. 11-74
Dusserre, P. 9-134

E

Ecker, A. 14-137, 14-141
Eckhardt, K. 12-264
Economou, S. 15-3
Edelstein, F. 18-166
EDSYN, Inc. 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55
Egbert, W. C. 8-63
Eggleston, D. 16-53, 16-58
Ehrhardt, J. 15-10, 15-13, 15-16, 15-19

Einspahr, H. 16-48, 16-53, 16-58
Ekbom, L. B. 13-6, 13-18
El-Aasser, M. S. 18-189, 18-195, 18-199, 18-203, 18-207
El-Faer, M. L. 17-199
Eliasson, A. 13-6, 13-18, 17-110, 17-116
Elleman, D. 6-44, 12-79, 12-82, 12-86, 12-90, 12-93, 12-98, 12-275
Elwell, J. K. 12-172
Ely, K. 16-18
Epp, L. 1-128
ESA-ESTEC 17-142
Eyer, A. 9-76, 9-91, 18-125, 18-127

F

Fabiniak, R. C. 5-3
Fabiniak, T. J. 5-3
Facemire, B. 2-6, 2-9, 8-7, 9-39, 11-3, 11-7, 12-27, 12-46
Favier, J. J. 9-125, 14-82, 14-85, 14-89, 14-93
Fazio, G. G. 12-271
Feuersanger, A. E. 18-131
Fichtl, G. H. 12-74, 12-260
Fischmeister, H. 17-86, 17-191, 17-196
Fiske, M. R. 11-91
Flemings, M. C. 6-57
Flocton, I. 10-72
Flugel, C. 8-27
Fontecilla, J. 16-53, 16-58
Fortezza, R. 12-240, 12-243
Fortune, W. S. 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55
Foster, K. 2-62
Fowlis, W. 12-260
Fredriksson, H. 13-6, 14-46, 14-49, 14-52, 14-55, 14-57, 14-59, 14-61, 14-65, 14-80, 17-80, 17-82, 17-86, 17-88, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116
Frieler, K. 18-8, 18-12
Fripp, A. L. 9-129
Frischat, G. H. 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-48, 11-50, 11-52
Frohberg, G. 11-65, 11-70
Frost, R. T. 6-17, 12-46
Froyen, L. 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35
Fujimoto, K. 12-246, 12-249, 14-145, 14-148

G

Gadsden, M. 15-57, 18-228
Galster, G. 8-48
Garriott, O. 12-38
Gatewood, J. R. 12-275
Gatos, H. C. 9-3, 9-5, 9-9, 9-14
Gauss, R. 2-3
Gautier, T. N. 12-271
Gelles, S. H. 17-34, 17-38, 17-43, 17-48
General Electric Space Division 12-298, 15-60
Gerpheide, G. E. 16-18
Ghersini, G. 14-120
Giebel, J. 17-230
Gilbert, C. R. 12-264
Gilman, P. 12-260
GM Vacuum Coating Laboratory 10-46, 18-238
Goans, M. 12-246, 12-249, 14-145, 14-148
Gondi, P. 4-47
Goodhew, P. J. 5-130, 5-132, 5-135
Graf, W. 5-121, 5-124, 13-11

Greenwell, E. N. 4-9, 4-13
Griffin, J. W. 18-234
Griffin, R. N. 1-3, 1-6
Grindeland, D. 1-69
Griner, C. S. 14-19, 14-23, 14-26, 14-29
Grodzka, P. G. 2-6, 2-9, 8-7, 9-39, 12-13, 12-18, 12-27
Gross, H. N. 18-28
Grote, M. 18-162
Grugni, G. 14-120
Guenoun, P. 7-24, 7-27

<u>**H**</u>

Haar, M. 8-84
Haessner, F. 14-69, 14-73
Hamakawa, Y. 9-57, 9-61, 9-63, 9-65, 9-67
Hammel, R. L. 17-3
Hammerstedt, R. 1-128
Hampp, R. 1-125
Hannig, K. 1-35, 1-41
Happe, R. A. 6-28, 6-32
Harris, J. M. 1-95, 1-101, 17-226, 17-230
Hart, J. E. 12-260
Harwell, R. J. 1-29
Hasemeyer, E. A. 6-3, 14-8, 14-11
Hatelid, Major J. E. 4-44, 14-109, 14-112, 18-28, 18-212
Hayes, J. W. 1-135, 1-152
Haynes, J. M. 12-175, 12-178, 12-181
Head, R. 12-24, 18-61
Hebert, D. J. 18-252
Hedvall, K. 15-72
Hehenkamp, Th. 11-89
Heide, W. 17-142, 17-146, 17-149, 17-152, 17-205
Henderson, A. J., Jr. 14-150, 14-153
Hendrick, J. 9-112
Herlach, D. M. 6-48, 6-52, 6-54
Hermanns, J. 11-55
Herr, K. 11-13
Hettwer, K. J. 14-69
Heye, W. 14-15
Hibbs, A. R. 12-38
High School for Engineering (The) 12-305
Hodes, E. 17-56
Hoefsloot, H.C.J. 12-321
Hoffer, D. 10-72
Hoffman, H. 12-264
Hoffmann, W. 12-271
Hoffmeister, H. 4-16, 4-19
Hogle, J. 16-22
Hopkins, W. G. 17-172
Horst, U. 11-52
Hymer, W. C. 1-69

<u>**I**</u>

Immorlica, A. A., Jr. 9-54
Irene, E. A. 10-20
Issel-Lyon, M. A. 8-27
Iwai, S. 8-22, 8-24
Izquierdo, M. 2-62, 8-81, 18-244, 18-247

<u>**J**</u>

Jamgotchian, H. 9-125
Janssen, L.P.B.M. 12-321
Jensen, B. C. 2-49, 12-190, 18-58, 18-159
Johannson, I. 8-48
John Curtis School of Medicine 16-25
Johnston-McCay, M. H. 14-19, 14-23, 14-26, 14-29, 14-32, 14-35
Johnston, R. G. 2-3
Joiner, B. 5-57, 5-62
Jones, N. 16-53, 16-58

K

Kamio, A. 17-181
Kattamis, T. Z. 9-41, 9-45, 9-48
Kawada, T. 5-41, 5-45
Kaye, S. 5-10
Kayser-Threde GmbH 8-30, 15-53, 18-135
Kedzierski, M. 15-60
Keith, G. H. 6-17
Kenney, D. M. 1-121
Kevy, S. V. 1-121
Kim, B. 1-121
Kim, K. S. 6-32
Kimura, S. 10-28, 10-33
Kimzey, J. H. 3-3
Kirschbaum, E. 15-63, 15-66, 15-69
Kitaura, T. 2-46, 2-49
Klaessig, F. C. 10-16
Klein, H. 7-33, 7-36, 14-116
Klemm, M. 14-15
Klett, R. 8-30, 15-53, 18-135
Kline, B. 12-298
Kneissl, A. 17-191
Knox, R. J. 1-29
Knuze, E. 1-128
Koch, D. G. 12-271
Koch, H. 18-144
Kölker, H. 9-84, 9-88
Kornfeld, D. M. 18-189, 18-195, 18-199, 18-203, 18-207
Korszun, Z. R. 16-70
Köstler, C. 11-89
Kozma, L. 18-15
Kraatz, K. M. 11-65, 11-70
Kreeb, H. 18-144
Krenitsky, T. 16-48
Kroes, R. L. 8-74, 9-51, 9-54, 12-40
Krutser, L.L.M. 15-78
Kumai, S. 17-181
Kurtz, E. 18-241
Kyr, P. 14-131

L

Lacy, L. L. 14-8, 14-11, 15-5, 17-14, 17-18
Lacy, P. 1-83
Lafferty, T. 18-252
Laher, R. R. 17-155
Lal, R. B. 8-74
Lamprecht, R. 12-162
Langbein, D. 5-140, 17-146, 17-149, 17-152, 17-205
Lange, R. 7-3, 7-5, 7-8
Lanham, J. W. 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 16-22
Larson, D. J., Jr. 6-3, 14-163, 17-6, 17-11, 17-22, 17-26, 17-30, 17-133
Launay, J. C. 10-68
Laver, G. 16-53, 16-58
Le Maguet, R. 14-82, 14-85
Lee, J. 8-55, 8-58
Lefaucheux, F. 8-34
Lefever, R. A. 9-19, 9-25
Legros, J. C. 12-194, 12-198, 12-201, 12-206, 12-209, 12-211
Leiste, H. 9-76
Leslie, F. 12-260
Lewis, M. L. 1-10, 1-73, 1-78
Lichtenbelt, J. H. 12-284, 12-307
Lierke, E. G. 18-64, 18-67, 18-71, 18-73
Limbourg, M. C. 12-206
Lind, M. D. 8-12, 8-17, 9-51, 9-54, 9-112
Lionetti, F. S. 1-121
Lipsett, F. 9-138
Littke, W. 16-3, 16-5, 16-8, 16-10, 16-12, 16-15
Löhberg, K. 17-51, 17-183
Lord, A. E., Jr. 6-21
Lovoy, C. V. 14-8, 14-11
Low, F. 12-271
Lu, P. 16-53, 16-58
Luttges, M. W. 1-135, 1-152
Luyendijk, T. 14-97, 14-100

M

Malmejac, Y. 11-62, 14-124, 14-126
Markworth, A. J. 17-34, 17-38, 17-43
Martin, M. 9-112
Martínez, I. 2-33, 2-52, 2-54, 2-58
Mason, P. V. 12-275
Matthews, J. 4-57
Mattox, D. M. 12-167
Maybee, G. W. 15-81
MBB-ERNO 14-116
McCreight, C. R. 18-169
McDonnell Douglas 12-252, 14-167
McDonnell Douglas Astronautics Company 12-252
McGee, K. 1-14
McIntosh, R. 18-169, 18-173, 18-178, 18-184
McKannan, E. C. 1-3, 14-3
McManus, S. P. 4-57
McPherson, A. 16-48, 16-53, 16-58
McShane, J. W. 10-46, 18-238
Meehan, E. 16-53
Megill, L. R. 2-46, 2-49, 12-187, 12-190, 15-57, 16-18, 18-25, 18-58, 18-156, 18-159, 18-228
Meier, M. 11-24, 11-33, 11-37, 11-44, 11-48, 11-50
Melnick, G. J. 12-271
Merkel, G. A. 15-3
Merkens, W. 11-55, 11-58
Meseguer, J. 2-28, 2-33, 2-58
Messerchmitt-Boelkow-Blohm (MBB/ERNO) 12-264
Methfessel, S. 17-210
Meyer, E. 6-3, 14-8, 14-11, 16-58
Meyyappan, M. 12-167
Micale, F. J. 1-29, 18-189, 18-195, 18-199, 18-203, 18-207
Miller, L. R. 8-67
Mishima, Y. 5-113
Mix, G. 15-26
Miyagawa, I. 8-3
Molitor, T. E. 2-3
Monti, R. 12-217, 12-222, 12-237, 12-240, 12-243
Moore, M. 8-81
Moore, R. G. 5-109, 12-172, 12-184, 14-105, 17-155, 18-22
Moos, P. J. 1-135, 1-152
Morgand, P. 4-51, 17-139
Morril, V. 14-167
Morrison, D. R. 1-10, 1-69, 1-73, 1-78, 16-65
Müller, G. 9-149, 9-153, 14-128, 14-131, 14-134
Müller, O. 1-90
Müller, W. 9-117, 9-121
Murphy, S. 9-112

N

Nagabhushan, T. L. 16-48, 16-53
Nagel, G. 8-38, 8-42, 8-45
Nähle, R. 12-289
Napolitano, L. G. 12-217, 12-222
NASDA 18-129
National Aeronautics and Space Administration (NASA)
Ames Research Center 18-169
Goddard Space Flight Center 18-169, 18-173, 18-178, 18-184
Marshall Space Flight Center 16-25, 16-31, 16-37, 16-42
Naval Research Lab 16-25
Navia, M. 16-48, 16-53, 16-58
Neel, R. R., II 4-44
Nerren, B. H. 1-29
Netter, G. 12-264
Neuhaus, D. 12-289, 12-294
Neuschütz, D. 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87
Newberry, R. 18-231

Newell, J. 4-55
Nielsen, K. F. 8-17, 8-48
Nieswaag, H. 14-97, 14-100, 18-116
Nii, K. 17-214
Nitsche, K. 7-11
Nitsche, R. 8-52, 9-76, 9-91, 9-117, 9-121, 10-65, 18-125, 18-127
Noojin, S. 13-21
Norek, M. 10-16
Nussle, R. C. 12-30

O

Oda, H. 10-28, 10-33
Ollendorf, S. 18-139, 18-169
Oran, W. A. 12-40
Orton, G. 12-252
Otto, E. W. 12-3
Otto, G. H. 15-5, 17-14, 17-159, 17-163
Owen, J. W. 18-166

P

Padday, J. F. 2-37, 2-41
Pallante, P. J. 12-24
Pan, C.H.T. 18-215
Pant, P. 4-27, 4-29, 4-32, 4-35, 17-120, 17-125, 17-128
Papazian, J. M. 9-41, 9-45, 9-48, 12-60, 12-65
Parr, R. A. 14-29, 14-32, 14-35
Partlow, D. P. 12-167
Pascherat, M. 8-30
Passerone, A. 17-217
Patel, D. 4-57
Patten, J. W. 4-9, 4-13
Patterson, A. 1-14
Patterson, W. J. 1-29
Pellegrino, J. 1-140, 1-144, 1-148
Perales, J. M. 2-58
Perez, R. 12-213
Perrot, F. 7-24, 7-27
Peter, L. J. 18-212
Peters, E. 5-7
Peterson, N. E., Jr. 18-173, 18-178
Petrac, D. 12-275
Petrash, D. A. 12-3
Pétré, G. 12-194, 12-206
Pfefferkorn, R. 17-191
Philippovich, N. 18-8
Pierre, J. 9-79, 9-81
Pinto, N. 6-17
Pirich, R. G. 17-133, 17-136
Politzer, H. 12-22
Pond, R. B. 4-22, 4-24, 11-79, 14-38, 14-42
Poorman, R. M. 14-3
Potard, C. 4-51, 9-134, 17-139
Pötschke, J. 4-27, 4-29, 4-32, 4-35, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-121, 5-124, 5-126
Praizey, J. P. 11-62, 11-82, 14-89
Preisser, F. 12-139, 12-144
Prinz, B. 17-222, 17-224
Purdy, D. 1-61, 1-65

R

Radcliffe, M. D. 8-67
Randolph, A. 8-99
Rankin, J. G. 18-149, 18-153
Raub, C. J. 15-22, 15-24
Ray, C. S. 6-39
Raymond, L. 5-48, 5-52
Redden, R. 9-144
Reed, R. E. 12-56
Reeder, R. J. 8-105
Reger, J. L. 17-3, 17-6, 17-11
Rejek, E. 15-69
Renzow, D. 2-16, 2-19, 2-21, 2-24
Rex, S. 14-159
Rey, D. 10-72

Rhim, W. K. 12-93
Rhodes, P. H. 1-10, 1-29
Rice, J. 12-298
Richman, D. W. 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-83
Richter, J. 11-55, 11-58, 15-63, 15-66, 15-69
Rieke, G. 12-271
Riepl, H. 15-53
Riley, C. 15-81
Robert, M. C. 8-34
Rodot, H. 9-95, 12-226
Rodriguez, N. 8-99
Rogge, V. 5-121, 5-124, 5-126, 13-14, 13-16
Rogoff, G. L. 18-131
Rose, J. 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-83
Rosenkranz, V. 11-28
Rossitto, F. 13-3, 14-120, 17-217
Roth, U. 5-140
Rothwell, H. L. 18-131
Rubenstein, M. 10-3
Rubin, B. 16-53, 16-58
Rüdiger, J. 4-19
Russo, G. 12-217

S

Sadeek, H. 10-16
Saffren, M. M. 12-79, 12-82, 12-86
Safman, R. 4-55
Sahm, P. R. 14-137, 14-141, 14-159
Salemme, R. 16-48
Sandermeier, P. 12-264
Sangiorgi, R. 17-217
Santandrea, R. 10-16
Sanz, A. 2-28, 2-33, 2-52, 2-54, 2-58
Sarma, K. 9-19, 9-25
Saturnelli, A. M. 8-95
Savage, C. 18-144
Scaife, C. W. 8-95
Schafer, C. F. 12-71, 12-74
Schäfer, W. 4-38, 4-41
Scharmann, A. 12-139, 12-144, 12-149, 12-153, 12-157, 12-162
Scharp, D. 1-83
Scheiber, M. M. 10-51
Schering Plough Corporation 16-25, 16-31, 16-37
Schlecker, H. 18-8
Schmitt, G. 18-135
Schnepple, W. F. 10-51
Schnettler, R. 1-105, 1-108, 1-111, 1-118
Schönholz, R. 8-52, 8-88, 10-65
Schoonen, M. 8-105
Schroder, F. S. 8-67
Schwabe, D. 12-139, 12-144, 12-149, 12-153, 12-157, 12-162
Schweitzer, K. 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-102, 18-220, 18-224
Scott, F. E. 1-29
Scripps Institute 16-25
Seaman, G.V.F. 1-29
Segawa, Y. 8-22, 8-24
Sell, P. J. 2-16, 2-19, 2-21, 2-24, 2-26
Sen, S. 9-19, 9-25
Senadhi, V. 16-58
Shahani, H. 14-61, 14-65
Sherhart, K. M. 12-22
Shifflett, L. 17-120, 17-125, 17-128
Shifler, D. A. 14-38, 14-42
Siegfried, E. 18-12
Siekmann, J. 12-289, 12-311, 12-316
Sigler, P. 16-58
Sikdar, S. 8-99
Smeesters, J. 4-3
Smith, H. D. 12-167
Smith, J. E. 13-21
Smith, R. W. 14-61
Snow, J. T. 12-213
Snyder, R. S. 1-6, 1-10, 1-17, 1-22, 1-26, 1-29, 1-48, 1-53, 1-101
Sona, P. G. 14-120

Sprenger, H. 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-102, 18-105, 18-108, 18-111, 18-116, 18-121, 18-123
Sprenger, S. 17-210
Stammers, D. 16-48, 16-58
Stapelmann, J. 18-135
State University of Antwerp 8-92
Steeg, M. 17-56
Steffen, J. E. 8-67
Stein, H. N. 15-76, 15-78
Steurer, W. H. 5-10
Stevens, J. 8-67
Stewart, R. 1-144
Stickler, R. 18-8, 18-12
Stodieck, L. S. 1-135, 1-152
Straub, J. 7-3, 7-5, 7-8, 7-11, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49
Streb, J. M. 14-112
Subramanian, R. S. 12-103, 12-167
Suddath, B. 16-58
Sunnerkrantz, P. A. 17-113
Surgenor, D. M. 1-121
Suzuki, T. 5-113, 5-116
Symons, E. P. 12-7
Szymanski, I. 1-121

T

Tachikawa, K. 17-214
Takahashi, S. 5-41, 5-45, 5-99, 5-104, 5-106
Takahashi, T. 17-181
Tegart, J. 12-256
Tensi, H. M. 11-86
Tezuka, T. 17-181
Thames, M. 12-301
Thomas, S. 12-184, 12-187, 12-190
Thomas, T. L. 14-105
Thompson, E. D. 10-72
Thurston, J. 18-247
Tillberg, E. 9-106
Tison, P. 9-156
Todd, P. 1-10, 1-69, 1-73, 1-144, 1-157, 1-161, 2-65, 11-95
Togano, K. 17-214
Toomre, J. 12-260
Trimmel, W. 17-191
Trinh, E. 12-98
Trumbauer, M. J. 18-61
Tschopp, A. 1-78, 1-86
Turner, D. J. 7-17, 7-21

U

Uelhoff, W. 12-56
Uhlmann, D. R. 5-57, 5-62, 5-66, 12-77
Ukanwa, A. O. 11-9
Umekawa, S. 5-113, 5-116
Union College 8-95
University of Alabama (Birmingham) 16-25, 16-31, 16-37, 16-42
University of Alabama at Huntsville 16-25
University of California 16-37, 16-42
University of Iowa 16-25
University of Pennsylvania 16-25
Unknown 1-35, 1-41, 1-95, 1-140, 1-144, 1-148, 1-157, 1-161, 2-6, 2-9, 2-16, 2-19, 2-21, 2-24, 2-26, 2-37, 2-41, 2-65, 4-16, 4-19, 4-22, 4-24, 4-47, 5-66, 5-90, 5-95, 5-116, 6-8, 6-13, 6-25, 6-48, 6-52, 6-54, 7-31, 7-33, 7-36, 8-7, 8-48, 8-52, 8-63, 8-84, 8-88, 8-99, 9-3, 9-5, 9-9, 9-14, 9-27, 9-39, 9-57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 10-3, 10-7, 10-12, 10-24, 10-68, 11-9, 11-62, 11-79, 11-86, 11-95, 12-27, 12-77, 12-93, 12-96, 12-103, 12-175, 12-178, 12-181, 12-194, 12-198, 12-201, 12-209, 12-211, 12-229, 12-233, 12-264,

13-3, 13-6, 13-11, 13-14, 13-16, 13-21, 14-15, 14-46, 14-49, 14-52, 14-55, 14-57, 14-59, 14-76, 14-78, 14-80, 14-89, 14-93, 14-120, 14-124, 14-126, 15-22, 15-24, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-63, 16-70, 17-18, 17-22, 17-34, 17-38, 17-48, 17-51, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-88, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-133, 17-136, 17-146, 17-149, 17-152, 17-175, 17-183, 17-187, 17-196, 17-199, 17-226, 17-230, 18-3, 18-15, 18-58, 18-64, 18-67, 18-71, 18-73, 18-77, 18-86, 18-89, 18-92, 18-95, 18-97, 18-99, 18-111, 18-116, 18-121, 18-123, 18-125, 18-127, 18-129, 18-153, 18-166, 18-169, 18-184, 18-215, 18-231

Urban, E. 12-271

Urbanek, J. 11-89

Utah State University 2-49, 12-190, 18-58, 18-159

V

Valluchi, M. 1-86

Van Alstine, J. M. 1-95, 1-101

van den Berg, L. 10-51

Vanderhoff, J. W. 1-29, 18-189, 18-195, 18-199, 18-203, 18-207

Van Doren, S. L. 14-38, 14-42

Van Oss, C. J. 1-29

Vardaman, W. K. 16-65

Vaughan, O. 12-42, 12-46, 12-50

Vera, I. 1-165, 1-170

Vits, P. 12-264

Vochten, R. F. 8-92

Voet, D. 16-58

Voltmer, F. W. 9-34

Vreeburg, J.P.B. 12-229, 12-233

W

Wagner, G. 16-63

Walden, V. 18-156, 18-159

Walker, C. 1-57, 1-61, 1-65, 16-22

Wall, S. B. 1-17

Walter, G. 15-16

Walter, H. U. 5-90, 5-95, 6-8, 6-13, 9-69, 9-73, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75

Wang, C. C. 10-20

Wang, T. G. 6-44, 12-50, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-275

Ward, K. 16-53, 16-58

Warren, R. 18-15

Weber, P. 16-53, 16-58

Wehr, P. 14-73

Weiker, D. 4-57

Weinzierl, A. 15-30, 15-32, 15-36, 15-39

Wesley, F. 12-305

Wessling, F. C. 4-57, 17-230

Wever, H. 11-65, 11-70

Whitaker, A. 2-13, 18-215

Whitten, F. 18-250

Wiedemeier, H. 10-7, 10-12, 10-16, 10-20, 10-24

Wilcox, W. R. 9-19, 9-25, 12-60, 12-65, 12-167, 17-26

Williams, J. R. 18-3

Wilson, I. A. 16-22

Winter, J. M. 4-22, 4-24

Wishnow, H. 18-241

Witt, A. F. 9-3, 9-5, 9-9, 9-14

Wospernov, W. 15-22

Wouch, G. 6-17, 6-21

Wozniak, G. 12-289, 12-311, 12-316

Wuenscher, H. 5-3, 5-7, 5-10, 17-3

Wuest, W. 12-129, 12-131, 12-135

Y

Yates, I. C. 5-3, 5-7, 5-10, 17-3, 17-14
Yee, J. F. 9-19, 9-25
Yeh, C. W. 9-31
Yoel, D. 5-109, 12-172, 12-305, 14-105, 17-155, 18-22
Yonath, A. 16-53, 16-58
Yoshida, Y. 17-214
Young, E. T. 12-271
Yue, A. S. 9-27, 9-31
Yue, B. K. 9-31
Yue, J. T. 9-34

Z

Zell, M. 15-36, 15-39, 15-41, 15-44, 15-49
Ziegler, G. 5-90, 5-95, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75
Zimmermann, U. 1-105, 1-108, 1-111, 1-113, 1-118
Zipp, G. 8-99

Index C: Payload Type

Payload Type Index

A

Apollo Command Module Payload (See also Skylab and ASTP) 1-3, 1-6, 5-3, 5-7, 5-10, 9-3, 12-7, 12-13, 12-18, 17-3

ASTP Docking Module Payload 9-31, 10-16, 12-56, 17-22

ASTP Manned Environment 1-29, 1-35, 2-6, 2-9, 2-13, 8-12, 9-14, 12-53

C

College Student Experiment 2-46, 2-49, 4-44, 5-109, 8-55, 8-58, 12-172, 12-187, 12-190, 12-213, 12-298, 12-301, 14-105, 14-109, 14-112, 15-60, 15-72, 17-155, 17-178, 18-22, 18-25, 18-28, 18-58, 18-156, 18-159, 18-212

F

Free-Flying Satellite (see STS Deployed Satellite)

G

Get Away Special (GAS) Canister (NASA), (See also MAUS Canister) 2-46, 2-49, 2-62, 4-44, 5-109, 8-30, 8-55, 8-58, 8-81, 9-138, 10-28, 10-33, 10-46, 12-172, 12-187, 12-190, 12-213, 12-246, 12-249, 12-252, 12-298, 12-301, 12-305, 14-105, 14-109, 14-112, 14-145, 14-148, 14-150, 14-153, 15-53, 15-57, 15-60, 16-18, 17-128, 17-155, 17-159, 17-178, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55, 18-58, 18-131, 18-135, 18-156, 18-159, 18-173, 18-178, 18-212, 18-224, 18-228, 18-238, 18-241, 18-244, 18-247, 18-250

H

High School Student Experiment 1-14, 2-3, 2-62, 4-55, 8-27, 8-30, 8-81, 8-95, 9-112, 10-28, 10-33, 10-72, 12-22, 12-24, 12-184, 12-305, 14-150, 14-153, 14-167, 15-3, 15-53, 18-61, 18-244, 18-247, 18-252

Hitchhiker (NASA) 18-184

L

Long Duration Exposure Facility (LDEF) 8-17, 18-162, 18-166, 18-169

M

Materials Experiment Assembly (MEA) (NASA, STS) 6-35, 6-39, 9-129, 10-20, 10-24, 11-79, 17-43, 17-48

Materials Science Laboratory (MSL) (NASA, STS), 6-57, 12-103, 14-163

MAUS Canister (West German Get Away Special (GAS) Canister) 11-28, 12-157, 12-264, 14-116, 17-125, 17-128, 17-159, 17-163, 18-220, 18-224

Mercury Capsule 12-3

Middeck Experiment (STS) 1-10, 1-22, 1-26, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-78, 1-83, 1-95, 1-101, 1-121, 4-55, 6-44, 8-27, 8-63, 8-67, 8-95, 9-112, 10-57, 10-62, 12-175, 12-184, 12-256, 14-167, 16-22, 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58, 17-26, 17-30, 17-199, 18-189, 18-195, 18-199, 18-203, 18-207, 18-252

O

OSTA 6-35, 10-20, 14-116, 17-43, 17-163

P

Payload Bay (STS) (Listing excludes Spacelab experiments) 2-46, 2-49, 2-62, 4-44, 5-109, 6-35, 6-39, 6-57, 8-30, 8-55, 8-58, 8-81, 9-129, 9-138, 10-20, 10-24, 10-28, 10-33, 10-46, 10-72, 11-28, 11-79, 12-103, 12-157, 12-172, 12-187, 12-190, 12-213, 12-246, 12-249, 12-252, 12-264, 12-271, 12-275, 12-298, 12-301, 12-305, 14-105, 14-109, 14-112, 14-116, 14-145, 14-148, 14-150, 14-153, 14-163, 15-53, 15-57, 15-60, 16-18, 17-43, 17-48, 17-125, 17-128, 17-155, 17-159, 17-163, 17-178, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55, 18-58, 18-131, 18-135, 18-139, 18-144, 18-149, 18-153, 18-156, 18-159, 18-173, 18-178, 18-184, 18-212, 18-220, 18-224, 18-228, 18-234, 18-238, 18-241, 18-244, 18-247, 18-250

S

Shuttle Student Involvement Program (SSIP) 4-55, 8-27, 8-95, 9-112, 12-184, 14-167, 18-252

Skylab Manned Environment 1-14, 1-17, 2-3, 3-3, 4-3, 5-41, 5-45, 6-3, 6-8, 6-13, 8-3, 8-7, 9-5, 9-9, 9-19, 9-25, 9-27, 9-34, 9-39, 10-3, 10-7, 10-12, 11-3, 11-7, 11-9, 12-22, 12-24, 12-27, 12-30, 12-34, 12-38, 12-40, 12-42, 12-46, 12-50, 14-3, 14-8, 14-11, 15-3, 15-5, 17-6, 17-11, 17-14, 18-3, 18-61

Skylab Student Project 1-14, 2-3, 12-22, 12-24, 15-3, 18-61

Sounding Rocket Experiment 1-41, 1-105, 1-108, 1-111, 1-113, 1-118, 1-125, 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-16, 2-19, 2-21, 2-24, 2-26, 2-52, 2-54, 2-58, 2-65, 4-9, 4-13, 4-16, 4-19, 4-22, 4-24, 4-27, 4-29, 4-32, 4-35, 4-38, 4-41, 4-57, 5-14, 5-18, 5-26, 5-33, 5-35, 5-39, 5-48, 5-52, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-87, 5-90, 5-95, 5-99, 5-104, 5-106, 5-113, 5-116, 5-118, 5-121, 5-124, 5-130, 5-132, 5-135, 6-17, 6-21, 6-25, 6-28, 6-32, 6-48, 6-52, 6-54, 7-3, 7-5, 7-8, 7-17, 7-21, 7-24, 7-27, 7-36, 8-22, 8-24, 8-92, 8-99, 8-105, 9-41, 9-45, 9-48, 9-51, 9-54, 9-

57, 9-61, 9-63, 9-65, 9-67, 9-69, 9-73, 9-76, 9-79, 9-81, 9-98, 9-101, 9-104, 9-106, 9-109, 9-117, 9-144, 9-149, 9-153, 9-156, 11-13, 11-17, 11-21, 11-33, 11-37, 11-44, 11-48, 11-50, 11-52, 11-55, 11-89, 11-91, 11-95, 12-60, 12-65, 12-71, 12-74, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-105, 12-109, 12-113, 12-115, 12-118, 12-121, 12-123, 12-126, 12-129, 12-131, 12-135, 12-139, 12-144, 12-149, 12-153, 12-167, 12-194, 12-198, 12-206, 12-209, 12-211, 12-237, 12-240, 12-243, 12-307, 12-311, 12-316, 12-321, 13-3, 13-6, 13-11, 13-14, 13-16, 13-18, 13-21, 14-15, 14-19, 14-23, 14-26, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-55, 14-59, 14-61, 14-65, 14-69, 14-73, 14-76, 14-78, 14-80, 14-82, 14-85, 14-97, 14-114, 14-131, 14-137, 15-10, 15-13, 15-16, 15-19, 15-22, 15-24, 15-26, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 15-63, 15-66, 15-69, 15-72, 15-76, 15-78, 15-81, 16-3, 16-5, 16-8, 16-10, 16-65, 16-70, 17-34, 17-38, 17-51, 17-56, 17-59, 17-63, 17-66, 17-69, 17-72, 17-75, 17-80, 17-82, 17-86, 17-88, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-133, 17-136, 17-139, 17-142, 17-146, 17-149, 17-152, 17-169, 17-175, 17-181, 17-210, 17-214, 17-217, 17-222, 17-224, 17-226, 17-230, 18-8, 18-15, 18-19, 18-64, 18-67, 18-71, 18-73, 18-77, 18-82, 18-86, 18-89, 18-92, 18-95, 18-97, 18-102, 18-105, 18-108, 18-121, 18-123, 18-125, 18-127, 18-129, 18-231

Spacelab Facility (STS) 1-86, 1-90, 2-28, 2-33, 2-37, 2-41, 4-47, 4-51, 5-22, 5-29, 5-85, 5-126, 5-140, 7-11, 7-33, 8-34, 8-38, 8-42, 8-45, 8-48, 8-52, 8-74, 8-84, 8-88, 9-84, 9-88, 9-91, 9-95, 9-121, 9-125, 9-134, 10-38, 10-43, 10-51, 10-65, 10-68, 11-24, 11-40, 11-58, 11-62, 11-65, 11-70, 11-74, 11-82, 11-86, 12-98, 12-162, 12-178, 12-181, 12-201, 12-217, 12-222, 12-226, 12-229, 12-233, 12-260, 12-280, 12-284, 12-289, 12-294, 14-57, 14-89, 14-93, 14-100, 14-120, 14-124, 14-126, 14-128, 14-134, 14-141, 14-159, 16-12, 16-15, 16-63, 17-172, 17-183, 17-187, 17-191, 17-196, 17-205, 18-12, 18-99, 18-111, 18-116, 18-215

SPAS 11-28, 12-157, 17-125, 18-144, 18-220

STS Deployed Satellite (See also Long Duration Exposure Facility and some SPAS) 8-17, 12-157, 17-125, 18-144, 18-162, 18-166, 18-169

U

Unknown 7-31

Index D: Processing Facility/Equipment Evaluated

Processing Facility/Equipment Evaluated Index

A

ACES see "Acoustic Containerless Experiment System"

acoustic apparatuses (in addition to the items listed under "acoustic" below, see "Acoustic Levitation" and/or "Acoustic Positioning" in the Key Words Index)

Acoustic Containerless Experiment System (ACES) 6-44

Acoustic Levitation Space Processing Rocket Instrument (ALSP) 12-96

acoustic mixers 17-142, 17-149, 17-181

ADSF see "Automated Directional Solidification Furnace"

ADSS see "Automated Directional Solidification System"

ALSP see "Acoustic Levitation Space Processing Rocket Instrument"

Apollo Electrophoresis Demonstration Unit (static column electrophoresis system) 1-3, 1-6

autoclave 7-17, 7-21

Automated Directional Solidification Furnace (ADSF) 14-163, 17-26, 17-30, 17-136, 17-175

Automated Directional Solidification System (ADSS) 17-133, 17-136, 17-175

B

ball launcher 12-246, 12-249

beam welder (electron) 6-3

brazing devices see "Brazing" in the Key Words Index

C

calorimeter see "Calorimetric Measurements" in the Key Words Index

capillary pumped evaporators (see also "Heat Pipes" in the Key Words Index)
18-173, 18-178, 18-184

capillary pumped loop heat pipe system (miniaturized) see also "Heat Pipes" in the Key Words Index
18-173, 18-178, 18-184

Cascaded Variable-Conductance Heat Pipe (CVCHP) 18-162

CFES see "Continuous Flow Electrophoresis System"

CGF see "Crystal Growth Furnace"

Charged Particle Mobility Device (CPMD) (for isotachophoresis) 1-17

chemical reactor (see also "MLR") 8-12, 8-17, 8-34, 8-48, 8-63, 8-67, 8-95, 18-189, 18-195, 18-199, 18-203, 18-207

chromatography system 18-250

codeposition devices see "Codeposition" in the Key Words Index

column electrophoresis unit 1-3, 1-6 (see also "Electrophoresis" in the Key Words Index)

condensers (see "Condensers" in the Key Words Index)

conductance autoclave see "autoclave"

constant-conductance heat pipes 18-144 (see also "Heat Pipes" in the Key Words Index)

Continuous Flow Electrophoresis System (CFES) 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83

cooled Infrared Telescope (IRT) 12-271

cooling apparatuses (see also "refrigerator" and "freezer"
- cold and hot plate (charged with saturated solution) 8-27
- cooling facility 12-311, 12-316
- cooling units (battery-powered thermoelectric) 14-19, 14-23, 14-26
- cooling/heating apparatus (exothermic) 4-24
- furnace with radial cooling 9-45, 9-48
- isothermal heating and cooling module within the General Purpose Rocket Furnace (GPRF)) 14-15

CPMD see "Charged Particle Mobility Device"

Critical Point Facility (see also "Critical Point Phenomena" in the Key Words Index) 7-24, 7-27

cryostat 12-275, 16-63

crystal growth facilities see "Crystal Growth From Solution," "Crystal Growth From the Melt," and "Crystal Growth From Vapor" in the Key Words Index

Crystal Growth Furnace (CGF) 9-109, 9-156

crystal growth furnaces see "furnace"

crystallization chamber see "Crystal Growth From Solution" in the Key Words Index

CVCHP see "Cascaded Variable-Conductance Heat Pipe"

D

DA see "Dialysis Apparatus"

DDM see "Drop Dynamics Module"

deposition cell/deposition device
In this index see (1) "electrodeposition cells," (2) "electrolytic cell," (3) "sputter deposition device," and (4) "vapor deposition

device." In the Key Words Index see (1) "Electrodeposition," (2) "Electrolysis," (3) "Sputter Deposition," and (4) "Vapor Deposition."

Dialysis Apparatus (DA) 16-25, 16-31, 16-37, 16-42

dielectrophoresis facility see "Dielectrophoresis" in the Key Words Index

differential interferometer (see also "interferometer") 12-118, 12-121, 12-198, 12-206, 15-49

diffusion apparatus/diffusion chamber (for a more complete listing see "Diffusion" and "Diffusion-Controlled Growth" in the Key Words Index)
- Diffusive Mixing of Organic Solutions (DMOS) Cell 8-63, 8-67
- Materials Dispersion Apparatus (MDA) Minilab 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-65, 8-99, 8-105, 11-91, 11-95, 16-65, 16-70
- Vapor Diffusion Apparatus (VDA) 16-25, 16-31, 16-37, 16-42, 16-58

Diffusive Mixing of Organic Solutions (DMOS) Cell 8-63, 8-67

directional solidification furnaces see "gradient furnace" (this index) and "Directional Solidification" in the Key Words Index

dispersion apparatus see "Materials Dispersion Apparatus Minilab (MDA)" (For a more complete listing see "Dispersion," "Dispersion Alloys," "Dispersion Layers," and "Dispersion Strengthening" in the Key Words Index.)

DMOS see "Diffusive Mixing of Organic Solutions"

double thermostat 7-27

Drop Dynamics Module (DDM) (see also "acoustic levitator" 12-98

droplet injector see "Droplet Injection" in the Key Words Index

E

ECPP see "Electromagnetic Containerless Processing Payload"

electric field see "Electric Field" in the Key Words Index

electrodeposition cells see "Electrocodeposition" and "Electrodeposition" in the Key Words Index

electrofusion facility see "Electrofusion" in the Key Words Index

electrolytic cell see "Electrolysis" in the Key Words Index

Electromagnetic Containerless Processing Payload (ECPP) 6-17, 6-21

electromagnetic levitation furnace 6-17

Electromagnetic Levitator (EML) 6-57

electron beam welder 6-3

electrophoresis systems see "Electrophoresis" in the Key Words Index

Electrophoresis Unit (EU) 1-29

ELLI see "Monoellipsoidal Mirror Furnace (ELLI)"

ellipsoidal see also "monoellipsoidal"

ellipsoidal mirror furnace (includes "monoellipsoidal mirror furnace"; see also "furnace" and "mirror furnace") 5-69, 5-72, 6-48, 6-52, 6-54, 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 9-76, 9-79, 9-84, 9-88, 9-91, 9-109, 9-117, 9-121, 9-156, 10-65, 14-49, 14-52, 14-76, 14-80, 14-134, 17-82, 17-86, 17-88, 17-90, 18-19, 18-67, 18-71, 18-73, 18-125, 18-127

ellipsoidal Mirror Furnace MF 4 and MF 8 see "Mirror Furnace MF #"

ellipsoidal mirror with halogen lamp 18-135

ellipsoidal reflector furnace see "monoellipsoidal reflector furnace"

elliptical mirror furnace (see also "mirror furnace") 17-113, 18-15

EML see "Electromagnetic Levitator"

EU see "Electrophoresis Unit"

evaporators see "Evaporators" in the Key Words Index

Experiment 77-13 Flight Apparatus 12-167

experiment module (TEXUS) see "TEXUS Experiment Modules"

experiment module (Swedish TEXUS) see "Swedish TEXUS Experiment Module"

F

FEA see "Fluid Experiment Apparatus"

FES see "Fluid Experiment System"

flammability facility 3-3

float zone apparatus see "Float Zones", "Liquid Bridges" and "Liquid Columns" in the Key Words Index

flowing junction cell see "Flowing-Junction Cell" in the Key Words Index

Fluid Experiment Apparatus (FEA) 9-112

Fluid Experiment System (FES) 8-74

fluid injection mechanism see "Liquid Injection" and "Liquid Transfer" in the Key Words Index

Fluid Module 2-21

Fluid Physics Module (FPM) 2-28, 2-33, 2-37, 2-41, 12-178, 12-181, 12-201, 12-217, 12-222, 12-226, 12-229, 12-233, 12-284, 12-289, 17-205

Fluid Science Module (FSM) 12-307, 12-311, 12-316, 12-321, 15-72

Fluids Experiment Apparatus (FEA) 9-112

Fluids Wetting and Spreading (FWS) Module 18-215

fluid transfer system see "Liquid Transfer" in the Key Words Index

focusing glass columns 1-22, 1-26

FPM see "Fluid Physics Module"

free flow electrophoresis apparatus see "Electrophoresis" in the Key Words Index

freezer (see also "Freezing" in the Key Words Index)
(cryogenic) 1-29
(food freezer) 9-39

FSM see "Fluid Science Module"

furnace (for more specific listings see "directional solidification furnace," "ellipsoidal mirror furnace," "elliptical mirror furnace," "gradient furnace," "heater," "isothermal furnace," and "mirror furnace") 4-3, 4-9, 4-13, 4-22, 4-27, 4-29, 4-38, 4-41, 4-47, 4-51, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-57, 5-69, 5-72, 5-82, 5-85, 5-87, 5-90, 5-99, 5-104, 5-106, 5-109, 5-113, 5-116, 5-118, 5-121, 5-124, 5-126, 5-130, 5-132, 5-135, 5-140, 6-8, 6-13, 6-17, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 8-22, 8-24, 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 8-92, 9-5, 9-9, 9-14, 9-19, 9-25, 9-27, 9-31, 9-34, 9-41, 9-45, 9-48, 9-51, 9-54, 9-57, 9-61, 9-63, 9-65, 9-67, 9-76, 9-79, 9-81, 9-84, 9-88, 9-91, 9-95, 9-98, 9-101, 9-104, 9-106, 9-109, 9-117, 9-121, 9-125, 9-129, 9-134, 9-144, 9-156, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-51, 10-65, 10-68, 11-9, 11-13, 11-17, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-62, 11-74, 11-79, 11-82, 11-86, 12-56, 12-60, 12-65, 12-71, 12-74, 13-3, 13-6, 13-11, 13-21, 14-8, 14-11, 14-29, 14-32, 14-35, 14-38, 14-42, 14-46, 14-49, 14-52, 14-57, 14-61, 14-65, 14-69, 14-73, 14-76, 14-78, 14-80, 14-89, 14-93, 14-97, 14-100, 14-105, 14-114, 14-116, 14-124, 14-126, 14-128, 14-134, 14-145, 14-148, 14-150, 14-153, 14-159, 14-163, 15-53, 17-6, 17-11, 17-18, 17-22, 17-26, 17-30, 17-34, 17-38, 17-43, 17-48, 17-51, 17-56, 17-59, 17-72, 17-80, 17-82, 17-86, 17-88, 17-90, 17-92, 17-95, 17-99, 17-102, 17-105, 17-107, 17-110, 17-113, 17-116, 17-120, 17-125, 17-128, 17-133, 17-136, 17-139, 17-142, 17-149, 17-159, 17-163, 17-169, 17-172, 17-175, 17-181, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 18-8, 18-12, 18-15, 18-19, 18-64, 18-67, 18-71, 18-73, 18-77, 18-82, 18-95, 18-97, 18-99, 18-102, 18-105, 18-111, 18-116, 18-125, 18-127, 18-220, 18-224

Furnace Heating Facility 14-105

FWS see "Fluid Wetting and Spreading Module"

G

General Purpose Rocket Furnace (GPRF) 4-22, 5-48, 5-52, 9-129, 10-24, 11-79, 14-38, 14-42, 17-34, 17-38, 17-43, 17-48, 17-51, 17-139

GEODE see "Gravity Experiment on Detector Elements (furnaces)"

Geophysical Fluid Flow Cell (GFFC) 12-260

GF 1 see "Gradient Furnace 1"

GF 2 see "Gradient Furnace 2"

GFA see "Gradient Furnace Assembly"

GFFC see "Geophysical Fluid Flow Cell"

GFQ see "Gradient Furnace with Quench"

G-GPRF see "Gradient General Purpose Rocket Furnace"

GHF see "Gradient Heating Facility Furnace"

GPRF see "General Purpose Rocket Furnace"

gradient furnace (see also "furnace" (this index) and "Directional Solidification" in the Key Words Index) 4-51, 5-33, 5-35, 5-132, 5-135, 9-14, 9-31, 9-95, 9-125, 9-129, 9-134, 10-16, 10-24, 10-68, 11-62, 11-74, 11-82, 11-86, 12-56, 14-46, 14-61, 14-65, 14-78, 14-89, 14-93, 14-128, 14-159, 17-18, 17-22, 17-43, 17-80, 17-95, 17-99, 17-102, 17-105, 17-110, 17-116

Gradient Furnace 1 (GF 1) 17-80

Gradient Furnace 2 (GF 2) 14-78

Gradient Furnace Assembly (GFA) 5-33, 5-35, 5-132, 5-135, 17-95, 17-99, 17-105, 17-110

Gradient Furnace with Quench (GFQ) 11-86

Gradient General Purpose Rocket Furnace (G-GPRF) 9-129, 10-24

Gradient Heating Facility (GHF) Furnace 4-51, 9-95, 9-125, 9-134, 10-68, 11-62, 11-82, 11-74, 14-89, 14-93, 14-128

Gravity Experiment on Detector Elements (GEODE) furnaces 9-144

H

halogen lamps see "Halogen Lamps" in the Key Words Index and "mirror furnace" in this index

hazardous fluids handling system 18-234

heater (see also "furnace") 4-24, 5-3, 5-7, 5-10, 5-87, 8-30, 9-144, 10-33, 12-172, 12-184, 12-194, 12-198, 12-206, 12-249, 12-311, 12-316, 14-15, 14-112, 14-116, 15-49, 15-60, 17-3, 17-155, 17-230, 18-22, 18-25, 18-31, 18-34, 18-58, 18-173, 18-178, 18-184

heater (water) 12-246, 12-249

heat exchangers see "Heat Exchangers" in the Key Words Index

Heat Pipe Experiment Package (HEPP) 18-169

heat pipe furnace 10-43

heat pipe radiator 18-149

heat pipes (see also "Heat Pipes" in the Key Words Index) 10-38, 10-43, 18-135, 18-139, 18-144, 18-149, 18-153, 18-156, 18-159, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184

heat radiators see "Heat Radiators" in the Key Words Index

helix chambers/helix fusion cells 1-105, 1-108, 1-111, 1-113

HEPP see "Heat Pipe Experiment Package"

High Performance Liquid Chromatography (HPLC) apparatus 18-250

High Precision Thermostat (HPT) 7-11

High Temperature Mirror Furnace (HTMF) (see also "mirror furnace") 13-6

High Temperature Thermostat (HTT) 11-65, 11-70

holographic interferometer see "Holography" and "Interferometric Measurements" in the Key Words Index

Holographic Optical Laboratory (HOLOP) 7-33, 12-280, 12-294, 14-141

HOLOP see "Holographic Optical Laboratory"

HPLC see "High Performance Liquid Chromatography"

HPT see "High Precision Thermostat"

HTMF see "High Temperature Mirror Furnace"

HTT see "High Temperature Thermostat"

I

IEF see "Isoelectric Focusing Apparatus"

I-GPRF see "Isothermal General Purpose Rocket Furnace"

IHF see "Isothermal Heating Facility Furnace"

IHF/G see "Isothermal Heating Facility with Gradient Device"

incubator 1-78, 1-86, 1-90

Infrared Telescope (IRT) 12-271

interferometer 7-33, 8-30, 11-58, 12-118, 12-121, 12-198, 12-206, 12-280, 12-294, 14-137, 14-141, 15-49

IRT see "Infrared Telescope"

Isoelectric Focusing (IEF) Apparatus 1-22, 1-26

isotachophoresis cell see "Isotachophoresis" in the Key Words Index

isothermal four-chamber furnace 4-27, 4-29, 11-13, 11-17, 11-33, 11-37, 11-44, 13-11, 14-97, 17-56, 17-59, 17-72, 17-125, 17-128, 17-214, 18-77, 18-82, 18-95, 18-97, 18-105

isothermal furnace
4-27, 4-29, 4-32, 4-35, 4-41, 4-47, 5-22, 5-29, 5-82, 5-85, 5-87, 5-90, 5-121, 5-124, 5-126, 5-140, 6-25, 11-13, 11-17, 11-24, 11-28, 11-33, 11-37, 11-40, 11-44, 11-79, 13-11, 14-15, 14-57, 14-69, 14-73, 14-97, 14-100, 14-124, 14-126, 15-53, 15-63, 15-66, 17-43, 17-48, 17-56, 17-59, 17-66, 17-69, 17-72, 17-75, 17-107, 17-113, 17-125, 17-128, 17-172, 17-183, 17-187, 17-191, 17-196, 17-210, 17-214, 17-217, 18-8, 18-12, 18-15, 18-64, 18-77, 18-82, 18-95, 18-97, 18-99, 18-102, 18-105, 18-111, 18-116

isothermal furnace module
see "TEXUS Experiment Module TEM 01-2" <Note: It is not clear if all entries under "TEM 01-2" represent an isothermal facility.>

Isothermal General Purpose Rocket Furnace (I-GPRF)
11-79, 17-48

isothermal heating and cooling module (within the General Purpose Rocket Furnace (GPRF)) 14-15

Isothermal Heating Facility (IHF) Furnace 4-27, 4-29, 4-47, 5-22, 5-29, 5-85, 5-87, 5-121, 5-124, 5-126, 5-140, 11-24, 11-40, 14-57, 14-100, 14-124, 14-126, 17-172, 17-183, 17-187, 17-191, 17-196, 17-210, 18-8, 18-12, 18-99, 18-111, 18-116

Isothermal Heating Facility with Gradient Device (IHF/G)
5-126, 14-100, 18-111

<u>**L**</u>

laser (Liquid Dye) 18-244
<Note: Although many experiments employed lasers as support equipment (i.e., to help determine sound absorption measurements or in illumination systems) the Liquid Dye Laser Experiment was designed to specifically determine the operation of the laser in space. For other laser citations see "Laser Light Scattering" in the Key Words Index.>

LCC see "Liquid Column Cell"

levitation furnace 6-17, 6-28, 6-32

levitator (see Acoustic Levitation" and "Electromagnetic Levitator" in the Key Words Index)

liquid bridge formation device see "Liquid Bridges", "Liquid Columns" and possibly "Float Zones" in the Key Words Index

liquid chromatography system 18-250

Liquid Column Cell (LCC) 2-52, 2-54, 2-58

liquid droplet injector see "Droplet Injection" in the Key Words Index

liquid dye laser (see note under "laser" (above)) 18-244

liquid injection mechanism (see "Liquid Injection" in the Key Words Index)

liquid-liquid diffusion apparatus see "diffusion apparatus"

Liquid Module 2-24

Liquid Phase Epitaxy (LPE) processor 9-54

liquid phase sintering device see "Liquid Phase Sintering" in the Key Words Index

liquid transfer mechanism (see "Liquid Transfer" and "Liquid Injection" in the Key Words Index)

Low-Gravity Exothermic Heating/Cooling Apparatus 4-24

Low Temperature Gradient Heating Facility (GHF) Furnace 4-51, 11-62, 14-128

LPE processor see "Liquid Phase Epitaxy (LPE) processor"

M

M512 Materials Processing Facility 14-3

Materials Dispersion Apparatus (MDA) Minilab 1-128, 1-135, 1-140, 1-144, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-65, 8-99, 8-105, 11-91, 11-95, 16-65, 16-70

MDA see "Materials Dispersion Apparatus (MDA) Minilab"

MEA see "Miniature Electrostatic Accelerometer"

MEFS see "Multipurpose Electric Furnace System"

MEFS (modified) (also known as MPEF) see "Multipurpose Electric Furnace (MPEF)"

metal ball launcher see "ball launcher"

metal halide arc lamps see "Arc Lamps" in the Key Words Index

M4 see "Multi-Mission Mirror Furnace Module"

MF see "Mirror Furnace (MF #")

MHF see "Mirror Heating Facility Furnace"

Miniature Electrostatic Accelerometer (MEA) 18-231

Mirror Furnace (MF #)
- MF 1 17-82
- MF 2 17-82
- MF 3 17-82
- MF 4 14-76, 17-169
- MF 5 5-72, 17-169
- MF 6 5-72, 17-169
- MF 7 14-52
- MF 8 14-80
- MF 9 17-82
- MF 10 17-86

mirror furnace (see also "ellipsoidal mirror furnace" and "furnace")
5-69, 5-72, 6-48, 6-52, 6-54, 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 9-76, 9-79, 9-84, 9-88, 9-91, 9-109, 9-117, 9-121, 9-156, 10-65, 13-6, 14-49, 14-52, 14-76, 14-80, 14-114, 14-134,17-82, 17-86, 17-88, 17-90, 17-92, 17-107, 17-113, 17-169, 17-217, 18-15, 18-19, 18-67, 18-71, 18-73, 18-127

Mirror Heating Facility (MHF) Furnace (see also "mirror furnace")
8-38, 8-42, 8-52, 8-88, 9-84, 9-88, 9-91, 9-121

mixing apparatus see "Liquid Mixing" or "Stirring of Components" in the Key Words Index

MLR see "Monodisperse Latex Reactor"

Monodisperse Latex Reactor (MLR) 18-189, 18-195, 18-199, 18-203, 18-207

Monoellipsoidal Mirror Furnace (ELLI) (see also "mirror furnace" or "ellipsoidal mirror furnace") 6-48, 6-52, 6-54, 8-45, 8-84, 9-76, 10-65, 14-134, 18-67, 18-71, 18-73

monoellipsoidal reflector furnace (see also "ellipsoidal mirror furnace") 9-117

MPEF see "Multipurpose Electric Furnace"

Multi-Mission Mirror Furnace Module (M4) (more mirror furnaces are listed under "mirror furnace") 17-107, 17-113, 17-217, 18-15

Multipurpose Electric Furnace (MPEF) (modified MEFS) 9-14, 9-31, 10-16, 12-56, 17-18, 17-22

Multipurpose Electric Furnace System (MEFS) 4-3, 5-41, 5-45, 6-8, 6-13, 9-5, 9-9, 9-19, 9-25, 9-27, 9-34, 10-7, 10-12, 11-9, 14-8, 14-11, 17-6, 17-11

Multipurpose Furnace
5-14, 5-18, 5-26, 17-120

P

parabolic reflector furnace
9-98, 9-101, 9-104, 9-106

Phase Partitioning Experiment (PPE) Unit 1-95

Phase Separation Experiment (PSE) Hardware 17-199

Physical Vapor Transport of Organic Solids (PVTOS) Facility
10-57, 10-62

piston see "Piston System" in the Key Words Index

plastic ball launcher see "ball launcher"

PPE see "Phase Partitioning Experiment Unit"

pressure chamber/vessel see the "Pressure..." titles in the Key Words Index

protein crystal growth facilities see "Protein Crystal Growth" in the Key Words Index

PSE see "Phase Separation Experiment Hardware"

pump see "Pump" in the Key Words Index

PVTOS see "Physical Vapor Transport of Organic Solids (PVTOS) Facility"

Q

quench facilities see "Quench Process" in the Key Words Index

R

radiators see "Radiators" and "Heat Radiators" in the Key Words Index

reactor see "chemical reactor"

refrigerator (see also "Refrigeration" in the Key Words Index) 15-5, 16-48, 16-53, 16-58

Refrigerator-Incubator Module (RIM) 16-48, 16-53, 16-58

resonant tube see "Acoustic Levitation" and "Acoustic Positioning" in the Key Words Index

RIM see "Refrigerator-Incubator Module"

S

SAAL see "Single Axis Acoustic Levitator"

scanning ratio calorimeter see "Calorimetric Measurements" in the Key Words Index

Schlieren-optical setup see "Schlieren-Optical Setup" in the Key Words Index

SFMD see "Storable Fluid Management Demonstration facility"

single axis levitation furnace see "Acoustic Levitation" in the Key Words Index

Single Axis Acoustic Levitator/Levitator-Furnace (SAAL) 6-35, 6-39, 12-77

SHARE see "Space Station Heat Pipe Advanced Radiator Element" ,

sintering furnace see "Liquid Phase Sintering" in the Key Words Index or "furnace" in this index

Slip Casting Thermostat Furnace 18-220, 18-224

snow generator 10-28, 10-33

soldering tools see "Soldering" and "Soldering-Related Tools" in the Key Words Index

Solute Diffusion Apparatus 8-17

Space Station Heat Pipe Advanced Radiator Element (SHARE) 18-153

space vacuum see "Space Vacuum" in the Key Words Index

sphere forming assembly (see also "Spheres" in the Key Words Index) 6-3

spin table 12-301

sputter deposition device 10-46

SSC/GF Module see "Swedish Space Corporation (SSC) Gradient Furnace Module"

static column electrophoresis facilities see "Electrophoresis" and "Static Column Electrophoresis" in the Key Words Index

STEM CELL see "Surface Tension Minimum (STEM) Cell"

stirring apparatus see "Stirring of Components," "Liquid Mixing" and "Mixing" in the Key Words Index)

Storable Fluid Management Demonstration (SFMD) facility 12-256

Super Fluid Helium Experiment Package 12-275

Surface Tension Minimum (STEM) Cell 12-201

Swedish Space Corporation (SSC) Gradient Furnace (SSC/GF) Module (MASER) 14-61, 14-65, 17-116

Swedish Space Corporation (SSC) Module Furnace see "Swedish TEXUS experiment module"

Swedish TEXUS experiment module 5-69, 5-72, 5-118, 5-130, 9-79, 13-6, 14-46, 14-49, 14-52, 17-80, 17-82, 17-86, 17-92, 17-95, 17-99, 17-102, 17-169

T

3AAL see "Three-Axis Acoustic Levitator"

TCU see "Temperature Control Unit (TCU) furnace"

TEM see "TEXUS Experiment Module"

Temperature Control Unit (TCU) furnace 4-9, 4-13, 12-71, 12-74

TEXUS Experiment Modules
TEM 01 5-76, 5-79, 17-120, 17-125, 17-128, 17-214, 18-77, 18-89, 18-92
TEM 01-1 4-27, 4-29, 4-38, 4-41, 5-26, 5-82, 5-87, 5-90, 5-95, 5-121, 5-124, 11-13, 11-17, 11-33, 11-44, 11-48, 11-50, 13-14, 13-16, 17-56, 17-59, 17-63, 17-72, 17-210, 17-222, 17-224, 18-8, 18-82, 18-95, 18-102, 18-105, 18-108, 18-121, 18-123
TEM 01-2 4-16, 4-19, 4-32, 4-35, 5-14, 5-18, 5-39, 5-124, 11-21, 11-37, 11-52, 11-89, 13-11, 13-18, 14-97, 17-66, 17-69, 17-75, 17-210, 18-86, 18-97
TEM 02 6-48, 6-52, 6-54, 14-69
TEM 02-1 6-25, 14-73, 17-142, 17-149, 18-64
TEM 02-1A 13-3
TEM 02-2 9-76, 18-67, 18-71, 18-73
TEM 02-3 9-117, 9-149, 9-153, 14-131
TEM 03 9-69, 9-73, 14-82, 14-85
TEM 06 (TEM 06 E) 2-16
TEM 06-1 12-105, 12-109, 12-113, 12-115, 12-118, 12-123, 12-126, 12-139
TEM 06-2 2-19, 2-21, 2-24, 2-26, 12-144, 12-149, 15-10, 15-22, 15-26
TEM 06-3 12-153, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 16-3, 16-5, 16-10
TEM 06-4 12-129, 12-131, 12-135, 12-237, 12-240, 12-243
TEM 06-5 1-105, 1-108, 1-125, 15-13, 15-16, 15-19, 16-8, 17-146, 17-152
TEM 06-6 12-121, 12-194, 14-137, 15-49
TEM 06-7 7-3, 7-5, 7-8, 15-24, 15-63, 15-66, 15-69
TEM 06-8 8-92, 11-55, 12-198, 12-206, 12-209, 12-211
TEM 06-9 (Liquid Column Cell (LCC)) 2-52, 2-54, 2-58
TEM 06-9 7-17, 7-21
TEM 06-10 7-24, 7-27
TEM 06-11 1-111, 1-113, 1-118
TEM 06-12 15-76, 15-78
TEM 06-13 1-41
TEM 06-14 7-36

TEXUS Swedish Experiment Module see "Swedish TEXUS experiment module"

Thermal Canister 18-139

thermostat/"thermostat" furnace 7-11, 7-27, 11-65, 11-70, 17-159, 17-163, 18-220, 18-224

three-axis acoustic levitator see "Acoustic Levitation" in the Key Words Index

Three-Axis Acoustic Levitator (3AAL) 12-103

transverse flat-plate heat pipes see "Heat Pipes" in the Key Words Index

triaxial acoustic levitation resonance chamber see "Acoustic Levitation" in the Key Words Index

__U__

UHV chamber see "Ultra-High Vacuum Chamber"

Ultra-High Vacuum (UHV) Chamber 14-120

Ultrasound Absorption Cell 15-63, 15-66, 15-69

unclear/unknown 1-118, 5-124, 7-31, 9-3, 11-7, 12-175, 14-55, 14-59, 16-15, 17-88, 18-125

V

Vapor Crystal Growth System (VCGS) 10-51

vapor deposition device see "Vapor Deposition" in the Key Words Index

Vapor Diffusion Apparatus (VDA) 16-25, 16-31, 16-37, 16-42, 16-48, 16-53, 16-58

Variable-Conductance Heat Pipes (VCHP) see "Heat Pipes" in the Key Words Index

VCGS see "Vapor Crystal Growth System"

VCHP see "Variable-Conductance Heat Pipes"

VDA see "Vapor Diffusion Apparatus"

vibration isolation systems see "Vibration Isolation Systems" in the Key Words Index

W

water ball generator 12-246, 12-249

water heating system 12-246, 12-249

welder (electron beam) 6-3

welders see "Welding" in the Key Words Index

wetting and spreading module see "Fluids Wetting and Spreading (FWS) Module"

X

X-ray unit 17-159, 17-163

Index E: Sample Materials

Sample Materials Index

A

A100H (boehmite) 1-144

accelerometers (see also the "Acceleration..." titles in the Key Words Index) <Note: this section lists accelerometers which were manifested as individual experiments, not those placed on low-g vehicles as "housekeeping" instrumentation.>
accelerometer 18-228
accelerometer (Kearfott 2412) 18-231
accelerometer (LGAS) 18-231
accelerometer (MEA) 18-231
accelerometer (QA-700) 18-231

acetate/acetic/acetone (see also "diacetinase," "ethylenediaminetetraacetic acid," and "mucopeptide N-acetylmuramoylhydrolase")
acetate 1-73, 1-113, 1-118, 1-140, 1-165, 8-95, 17-3
acetate (Ca-) 1-113, 1-118
acetate (cellulose) 1-165
acetate (lead) 8-95
acetate (Mg-) 1-113
acetate (polyglucosamin) 1-140
acetate (potassium) 1-118
acetate (sodium) 17-3
acetate (sodium acetate trihydrate) 17-3
acetate (triethanolamine-potassium) 1-73
acetic acid 12-105
acetone 1-140, 1-165, 12-115, 12-123, 12-126, 12-284
acetone-water solution 12-307, 12-321

acetonitrile 8-17

acid
acid (acetic) 12-105
acid (amino, serine) 1-29
acid (ethylenediaminetetra-acetic) 1-29
acid (folic) 1-78
acid (hydrochloric) 2-9
acid (isobutyric acid-water system) 7-31
acid (nicotinic) 1-78
acid (phosphoric) 1-29, 8-34
acid (salmon sperm deoxyribonucleic acid (DNA)) (see also "DNA") 1-3
acid (sulfuric) 8-48

acidic solution (see also "Solutions" in the Key Words Index) 16-37

acrylonitrile 17-230

Ag* (listed as the primary element) see also "silver"
Ag* 4-3, 10-46, 10-72, 13-3, 15-22, 15-26, 18-102
Ag*Ag*Cl* 15-26
Ag*Al*O* 5-90, 5-95
Ag*Cl* 15-26
Ag*Cu* 4-47
Ag*Cu*Al*O* 4-47
Ag*Cu*Li* 18-3, 18-8, 18-12
Ag-Cu with additions of Al_2O_3 particles (see also "Ag*Cu*Al*O*" and "Al_2O_3 particles") 4-47
Ag*Ge* 14-89, 14-124, 14-126
Ag*I* 10-28, 10-33
Ag*I*K*I* 11-74
Ag*N*O* 8-92, 8-105, 11-52, 11-55, 11-58, 15-63, 15-66, 15-69

Ag*Na* 17-59, 17-63, 17-66, 17-69, 17-72
Ag*Ni* 8-7
Ag* particles 17-59, 17-63, 17-66, 17-69, 17-72
Ag*Sb* 6-25, 18-64
Ag*Si*C* 5-41, 5-45
Ag*W* 5-95
Ag*W*Ni*Cu* 5-95

Ag* (listed as a secondary element) see also "silver"
Au*Ag*Cu* 18-12
Cu*Ag*Ti* 18-15
Na*N*O*Ag*N*O* (see also "salt") 11-52
Ni*Ag* 6-3, 18-3
Pb*Ag*Ba*O* 14-15
Rb*N*O*Ag*N*O* 15-66
Sn*Ag* 11-82, 14-61, 18-19
W*Ag* 5-90, 13-3

air (see also "gas" (this index) and the "Gas..." titles in the Key Words Index)
air 1-140, 1-144, 1-148, 1-165, 1-170, 4-55, 8-99
air and water (see also "water") 12-42
air bubble 12-24
air bubbles 12-289
air for gas bubbles 12-294

AISI steel (see also "steel")
AISI 325 steel 14-120
AISI 420 steel 14-120

AK silicone oil (see also "silicone oil" and "oil")
AK 10 silicone oil 12-131
AK 100 silicone oil 12-289

AK&F 104662 16-53

Al* (listed as the primary element) see also "aluminum" and "alumina"
Al* 4-16, 4-41, 5-22, 5-135, 10-46, 10-72, 12-18, 14-3, 14-9, 14-69, 18-61, 18-220, 18-224
Al-alumina fiber (see also "fiber") 5-118, 5-130, 5-132
Al with fine dispersions of Al_2O_3 4-47
Al*Al*O* 5-118, 5-130, 5-132
Al*Ar* 4-9, 4-13
Al*Bi* 17-72, 17-75
Al*Cu* 5-69, 5-72, 11-86, 14-8, 14-11, 14-35, 14-46, 14-57, 14-65, 14-69, 14-82, 14-85, 14-89, 14-93, 14-114, 14-150
Al*Cu*Al* 14-82, 14-85
Al*Cu*Al*O* 5-69, 5-72
Al*Ge* 14-124, 14-126
Al*In* 17-34, 17-38, 17-43, 17-48, 17-51, 17-75, 17-139, 17-181, 17-186, 17-196
Al*Mg* 4-19, 14-159, 18-86, 18-89, 18-92
Al*Mo* 14-69
Al*Nb* 5-118, 5-130, 5-132, 14-69
Al*Ni* 4-47, 14-69, 14-85, 14-89
Al*O* 4-29, 4-47, 5-22, 5-69, 5-72, 5-90, 5-95, 5-118, 5-130, 5-132, 6-35, 6-39, 15-10, 15-13, 15-16, 15-19, 18-15, 18-220, 18-224
Al_2O_3 inclusions 4-29
Al_2O_3 particles (see also "particles") 4-47, 18-105
Al*Pb* 17-75, 17-169, 17-172, 17-187
Al*Pb*Bi* 17-214
Al*Pb*Si*Cu*Sn* 17-56
Al*Sb* 17-18
Al*Si* 11-86, 14-52, 14-80, 14-124, 14-126
Al*Si*Bi* 17-222, 17-224
Al*Si*C* 5-22, 5-33, 5-35
Al*Si*O* 10-46
Al*Ta* 14-69
Al*Ti* 14-69, 14-76
Al*Ti*H* 4-41
Al*Zn* 4-51
Al*Zr* 5-118, 5-130, 5-132

Al* (listed as a secondary element) see also "aluminum"
Ag*Al*O* 5-90, 5-95
Ag*Cu*Al*O* 4-47
Cu*Al*O* 5-22, 5-29, 5-76, 5-79, 5-82, 5-85, 5-121, 5-126, 18-105
Cu*Ti*Al*Ti* 14-73
Cu*Ti*Al*V* 14-73
Fe*C*Al*Si*O* 4-32
K*Al*S* 8-81
Ni*Al*Mo* 18-99, 18-111
Ni*Cu*Al* 11-89
Si*O*Na*O*Al*O* (glass) 11-52
Sn*Al* 14-59
Ti*Al*V* 14-167

albumin 1-22, 1-26, 1-43, 1-48, 1-65, 1-113, 1-118, 16-42, 16-48, 16-58
albumin (bovine serum) 1-118
albumin (egg) 1-43, 1-48
albumin (human serum) 1-65, 16-42, 16-48, 16-58
albumin (rat) 1-43, 1-48
albumin (serum) 1-65, 1-113, 1-118

alcohol
alcohol (amyl) 12-105, 12-109
alcohol (ethanol) see also "ethanol" 11-91, 12-311, 12-316, 14-137, 14-141, 15-72, 17-199
alcohol (ethyl) 2-9
alcohol (methyl) 1-148, 7-24, 7-27, 8-63, 8-67, 12-135, 17-146, 17-152
alcohol oxidase 16-53

aldose reductase 16-58

alkali silicate (see also "silicate" (this index) and "Alkaline Glasses" in the Key Words Index)
alkali silicate melts 11-44
alkali silicate-lead glass beads (see also "beads" and "glass") 5-57

Alka-Seltzer tablets 12-38

Allied Chemical's METGLAS 2826 6-21

alloys see "Alloys" and "Metals and Alloys" in the Key Words Index

alpha furil dioxine 17-199

alpha2-interferon (see also "interferon") 16-25, 16-31, 16-37

alumina (see also "Al*O*") 5-76, 5-79, 5-82, 5-85, 5-118, 5-121, 5-130, 5-132, 5-135, 6-35, 6-39, 18-15
alumina fiber (see also "fiber") 5-118, 5-130, 5-132, 5-135
alumina particles (see also "Al*O*" and "particles") 5-22, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-126, 15-10, 15-13, 15-16, 15-19

aluminized mylar

aluminum (for the majority of the listings see "Al*")
aluminum coating (see also "coating") 10-46, 10-72
aluminum containing pores (see also "Pores," "Porosity" and the "Porous..." titles in the Key Words Index) 4-41
aluminum flakes (see also "flakes") 12-184
aluminum (metal dissolved in liquid aluminum) 14-69
aluminum powder (see also "powder") 12-18, 12-187, 12-190

aluminum with titanium hydride additions (see also "Al*Ti*H*") 4-41

ammonia/ammonium (see also "N*H*")
ammonia 1-14, 18-139, 18-153, 18-162, 18-173, 18-178, 18-184
ammonium chloride (see also "N*H*Cl*") 14-19, 14-23, 14-26
ammonium phosphate (hydrogen ammonium phosphate) see also "phosph..." 8-34
ammonium sulfate 16-5, 16-8, 16-10, 16-15, 16-31

amorphous materials see "Amorphous Materials" in the Key Words Index

amphibian Ringer's salt solution (see also "salt" (this index)) 1-128

amyl alcohol (see also "alcohol") 12-105, 12-109

animal cells (see "cells")

anionic polymer (see also "polymer") 18-252

anode (see also "Anode" in the Key Words Index)
anode (nickel) 15-10, 15-13, 15-16, 15-19

antibody (see also "Antibodies" in the Key Words Index) 16-25, 16-65
antibody (Anti Leu-1 monoclonal antibody (MAb)) 16-65
antibody (fab monoclonal antibody component) 16-25
antibody (monoclonal antibody complexes of neuramindase from influenza virus) see also "neuramindase" 16-25

antifoaming ingredient (Dow Corning FC-10) see also "foam" (this index) and the "Foam..." titles in the Key Words Index 12-256

antimony/antimonide (for the majority of the listings see "Sb*")
antimony-doped germanium (see also "Ge*Sb*") 9-34
indium-antimonide doped with selenium (see also "In*Sb*Se*") 6-13
indium-antimonide doped with tin (see also "In*Sb*Sn*") 9-134
indium-antimony doped with tellurium (see also "In*Sb*Te*") 9-3, 9-5
indium-antimony doped with tin (see also "In*Sb*Sn*") 9-5

Apiezon Cn 18-215

aqueous solution see "Aqueous Solutions" in the Key Words Index

aqueous two-phase (immiscible) systems see the "Immiscible..." titles in the Key Words Index

Ar* (argon) see also "argon" 5-7, 9-91, 10-16, 10-38, 10-43, 12-18, 12-60, 17-3

Ar* (listed as a secondary element) see also "argon"
Al*Ar* 4-9, 4-13
C*Br*Ar* 12-60, 12-65
In*Bi*Si*C*Ar* 5-7

argon
argon and copper-coated tungsten spheres (see also "spheres") 5-7

aridicin aglycone 16-53, 16-58

arsenic see "As*"

As* (arsenic) listed as the primary element
no listings

As* (arsenic) listed as a secondary element
Ga*As* 9-51, 9-54, 9-149, 9-153, 10-3
Si*As*Te* 9-57, 9-61, 9-63, 9-65, 9-67

Au* (listed as the primary element) see also "gold"
Au* 10-46, 10-72, 11-89, 12-56, 15-10, 15-13, 15-16, 15-19
Au*Ag*Cu* 18-12
Au*Ge* 17-6, 17-11
Au*Si* 14-124, 14-126

Au* (listed as a secondary element) see also "gold"
Ni*Cu*Au* 11-89
Pb*Au* 12-56

Avional 2024 alloy (see also "Alloys" in the Key Words Index) 4-47

B

B* (listed as the primary element) see also "boron"
B*C* 5-3
B*N* 17-217

B* (listed as a secondary element) see also "boron"
Cu*B*C* 5-3
Cu*Ti*B* 14-73
Fe*Ni*P*B* 6-21
Ge*B* 9-34
H*B*O* 8-92
H*B*O*Na*N*O*H* 1-6
Na*B*Na*O* 12-167
Na*O*B*O* 6-35, 6-39
Na*O*B*O*Si*O* 11-40
Na*O*B*O*Si*O*Pt* 11-40
Pb*O*B* 5-116
Si*B* 9-117
Si*P*B* 9-121

Ba* (barium) listed as the primary element
no listings

Ba* (barium) listed as a secondary element
Pb*Ag*Ba*O* 14-15
Zr*F*Ba*F*La*F* 6-44

bacterial purine nucleoside phosphorylase-PNP (see also "purine nucleoside phosphorylase") 16-25, 16-31, 16-42

bacteriorhodopsin 16-63

bactopeptone 1-78

barium see "Ba*"

Be* (beryllium) listed as the primary element
Be*Cu* (beryllium copper fibers) 5-10
Be*O* 6-17

Be* (beryllium) listed as a secondary element
In*Bi*Be*Cu* 5-10

beads (see also "particles," "spheres," and "tracers...") 1-78, 5-57, 5-62, 5-66, 12-22, 17-199

beads (glass) (see also "glass") 5-57, 5-62, 5-66, 17-199
beads (microcarrier) 1-78
beads (plastic) 12-22

beams
beams (cantilevered) 18-61
beams (joined with solder) (see also "solder") 18-28

benzylbenzoate 17-205

beryllium see "Be*"

Beta-D galactoside galactohydrolase 16-12

beta-galactosidase 16-3, 16-5, 16-8, 16-10, 16-12, 16-15

Bi* (listed as the primary element) see also "bismuth"
Bi*Mn*Bi* 17-26, 17-133, 17-136, 17-175
Bi*Sn* 11-82, 14-105
Bi*Zn* 17-82

Bi* (listed as a secondary element) see also "bismuth"
Al*Bi* 17-72, 17-75
Al*Pb*Bi* 17-214
Al*Si*Bi* 17-222, 17-224
In*Bi* 5-3, 5-7
In*Bi*Be*Cu* 5-10
In*Bi*Si*C*Ar* 5-7
Mn*Bi* 17-22, 17-30, 17-120, 17-125, 17-128
Pb*Bi* 4-55
Sn*Bi* 11-82, 14-32
Zn*Bi* 17-90, 17-92, 17-102, 17-105, 17-107, 17-110, 17-113, 17-183, 17-187, 17-217
Zn*Bi*Cu* 17-99
Zn*Bi*Mg* 17-99
Zn*Bi*Pb* 17-183, 17-187
Zn*Pb*Bi* 17-187

binary systems see "Binary Systems" in the Key Words Index

bioceramics see "Bioceramics" in the Key Words Index

biological cells see "cells" (this index) and "Biological Cells" and the "Cell..." titles in the Key Words Index

bismuth (for the majority of listings see "Bi*")
bismuth and lead (cerallow) 4-55
bismuth-indium eutectic powder 5-3

blood cells see "cells" (this index) and (1) "Biological Cells" and (2) the "Cell..." titles (in the Key Words Index)

blue (see also "dye")
blue dye mixed with oil 12-53
blue food coloring 12-256
blue (methylene blue) 8-67
blue (thymol blue dye) 2-9
blue (trypan blue dye) 1-157, 1-161, 2-65, 11-95, 17-199

boehmite 1-144

bone marrow cells see "cells" and "rat bone marrow cells" (this index) and "Biological Cells" and "Human Bone Marrow Transplants" in the Key Words Index

borate
borate (dilute) (see also "H*B*O*Na*N*O*H*") 1-6
borate glass (sodium-borate) 12-167

boron (for the majority of the listings see "B*")
boron carbide spheres (copper coated) see also "spheres" 5-3
boron deposits in phosphorous doped silicon (see also "Si*P*B*" and the "phosph... titles) 9-121
boron-doped germanium 9-34
boron-doped silicon 9-117
boron nitride plates 17-217

bovine
bovine pancreatic pro-carboxypeptidase 16-53
bovine serum albumin (Serva) (see also "albumin") 1-118
bovine serum (fetal) 1-78

Br* (listed as the primary element) see "bromide/bromine" (no other listings)

Br* (listed as a secondary element) see also "bromide/bromine"
C*Br* 12-60, 12-65
C*Br*Ar* 12-60, 12-65
C*Br*H* 12-60
C*Br*N* 12-60
Hg*Br* 8-92

brass 18-28

braze alloy (see also "Alloys" and "Brazing" in the Key Words Index) 18-3

braze metal (see also "Brazing" and the "Metal..." titles in the Key Words Index) 18-15

bromide/bromine (for the majority of the listings see "Br*")
carbon tetrabromide 12-60
carbon tetrabromide saturated with argon, hydrogen, or nitrogen (C*Br*Ar*, C*Br*H*, C*Br*N*) 12-60

brushite 8-34

B-staged (partially cured) E-7k7/PW-70 epoxy-resin-graphite (see also "epoxy resin") 5-109

buffer
buffer 1-6, 1-17, 1-29, 1-73, 1-95, 1-128, 1-135, 1-157, 8-99, 16-63, 18-189, 18-199
buffer (chloride-tris) 1-17
buffer (collagen initiation) 1-135
buffered (phosphate-buffered saline) see also "salt" 1-78, 1-121
buffered solutions 1-22, 1-26
buffer gas (see also "gas") 10-20, 10-24, 10-57, 10-62
buffer materials 1-3
buffer (phosphate) 1-78, 1-95, 1-121, 1-157, 8-99, 16-5, 16-8, 16-10
buffer (Ringer's Amphibian Buffer (RAB)) 1-128
buffer solution 1-35, 16-5, 16-8, 16-10, 16-12, 16-15
buffer (suspending) 1-10

butadiene 17-230

C

C* (listed as the primary element) see also "carbide," "carbon," "carbonate," and "carboxi-/carboxy"
C* 14-97
C*Br* 12-60, 12-65
C*Br*Ar* 12-60, 12-65
C*Br*H* 12-60

C*Br*N* 12-60
C*F* 10-62
C*H* (ethane C_2H_6) 18-169
C*H*C*S*N*H* 8-17
C*H*O* 5-62, 5-66, 9-41, 12-162
C*H*O*Ni* 5-62, 5-66

C* (listed as a secondary element) see also "carbide," "carbon," "carbonate," and "carboxi-/carboxy"
Ag*Si*C* 5-41, 5-45
Al*Si*C* 5-22, 5-33, 5-35
B*C* 5-3
Ca*C*H*O* 8-12, 8-48
Ca*C*O* 8-12, 8-17, 8-48
Co*Cr*C* 15-81
Co*W*C* 13-11
Cu*B*C* 5-3
Cu*O*C* 4-24
Cu*Si*C* 5-14, 5-22, 5-29
Cu*Sn*Cu*O*C* 4-38
Fe*C*Al*Si*O* 4-32
Fe*C*Si*O* 4-32, 4-35
Fe*C*Si*P*S* 14-101
Fe*C*Si*S* 18-116
In*Bi*Si*C*Ar* 5-7
K*Pt*C*N*H*O* 8-55, 8-58
N*H*C*H*C*O*H* 8-27, 8-74
N*H*H*C*O* 8-17
N*H*Pt*C*O* 8-48
Na*C* 4-44, 18-189, 18-199
Na*H*C*O* 1-78
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Mo*Ti*C* 5-99, 5-104, 5-106
Pb*C*H*O* 8-95
Si*C* 5-7, 5-33, 5-35
Ti*C* 5-99, 5-104, 5-106
W*C*Co* 5-124

Ca* (listed as the primary element) see also "calcium"
Ca-acetate 1-113, 1-118
Ca*C*H*O* (calcium tartrate) 8-12, 8-48
Ca*C*O* 8-17
Ca*C*O* (calcium carbonate) 8-12, 8-17, 8-48
$CaCO_3$ grown from $CaCl_2$ and NH_4HCO_3 in water 8-17
Ca*Cl* 8-17
Ca*N*O*N*H*H*P*O* 8-34
Ca*O*Ga*O*Si*O 6-28, 6-32

Ca* (listed as a secondary element) see also "calcium"
Ga*O*Ca*O* 6-35, 6-39
Ga*O*Ca*O*Si*O* 6-28, 6-32, 6-35, 6-39

cadmium (for the majority of the listings see "Cd*")
cadmium rods 9-138
cadmium telluride (see also "Cd*Te*") 8-52, 8-88, 9-144, 10-65
cadmium telluride doped with chlorine (see also "Cd*Te*Cl*") 8-88

calcium (for the majority of the listings see "Ca*")
calcium carbonate (see also "Ca*C*O*") 8-12, 8-17, 8-48
calcium nitrate 8-34
calcium-tartrate (see also "Ca*C*H*O*") 8-12, 8-48
gallia-calcia glass (see also "glass") 6-28, 6-32

camphor (d-camphor) 5-62, 5-66

canavalin (see also "concanavalin") 16-37, 16-42, 16-48, 16-53, 16-58

cantilevered spring beam 18-61

carbide (see also "C*")
carbide (cobalt-tungsten) 5-124

carbide particles (see also listings directly below) 5-14, 5-22, 5-99, 5-106
carbide particles (silicon carbide) (see also "particles") 5-14, 5-22
carbide particles (titanium carbide) 5-99, 5-106
carbide (silicon carbide) 5-14, 5-22, 5-29
carbide spheres (boron-carbide) (see also "particles" and "spheres") 5-3
carbide whiskers (titanium-carbide) 5-99

carbon (for the majority of the listings see "C*")
carbon dioxide 12-13
carbon fibers (see also "fiber") 5-113
carbon tetrabromide (see also "C*Br*") 12-60
carbon tetrabromide saturated with argon, hydrogen or nitrogen (see also "C*Br*Ar*," "C*Br*H*," and "C*Br*N*") 12-60
fluorocarbon blowing agent 4-57
perfluorinated hydrocarbon 12-213

carbonate (see also "C*")
calcium carbonate 8-12, 8-17, 8-48
sodium bicarbonate (see also "Na*C*") 4-44, 18-189, 18-199

carboxi-/carboxy (see also "C*")
10-bis(dicarboximide) 10-57
bovine pancreatic pro-carboxypeptisdase 16-53
carboxy-terminated copolymers (see also "polymer") 17-230

cast iron (see also "iron" and "Fe*") 14-97, 14-101

catalase 16-58

catalyst (see also "Catalysts" in the Key Words Index) 4-57, 17-230

cathode (see also "Cathode" in the Key Words Index)
cathode (gold) 15-10, 15-13, 15-16
cathode (plated) 15-22, 15-24

cationic polymer (see also "polymer") 18-252

Cd* (listed as the primary element) see also "cadmium"
Cd* 9-138
Cd*Hg*Te*, 9-144
Cd*Te* 8-52, 8-88, 9-144, 10-65
Cd*Te*Cl* 8-88

Cd* (listed as a secondary element) see also "cadmium"
Hg*Cd*Te* 9-144

Ce* (cerium) listed as the primary element
Ce*Cu* 6-3
Ce*Cu*Co* 17-22
Ce*Mg* 9-79, 9-81

Ce* (cerrium) listed as the secondary element
no listings

C elastomers 17-230

cell/cells (see also "Biological Cells" and the "Cell..." titles in the Key Words index)
cell culture fluid 1-57, 1-61, 1-65

cell culture medium (see also "media/medium," "proprietary tissue/cell culture media," and "tissue culture media") 1-86, 1-90
cell (engineered cell line) 1-65
cell fusion media 1-113, 1-118
cell (hybridoma cell line) see also "hybridoma" 1-113
cells 1-10, 1-17, 1-29, 1-35, 1-69, 1-73, 1-78, 1-83, 1-86, 1-90, 1-113, 1-121
cells (erythrocytes) see "cells (red blood)"
cells (HEK) 1-78
cells (horse red blood cells) 1-29
cells (human embryonic or fetal) 1-29, 1-73
cells (kidney) 1-29, 1-73
cells (human kidney) 1-10, 1-29, 1-73, 1-10
cells (human red blood) 1-17, 1-29, 1-121
cells (pancreatic) see also "pancreatic" 1-83
cells (pituitary rat) 1-69
cells (rabbit red blood) 1-10, 1-29
cells (rat bone marrow) 1-35
cells (rat lymph node) 1-35
cells (rat spleen) 1-35
cells (red blood) 1-10, 1-17, 1-29, 1-35, 1-41, 1-121
cells (SP2) 1-113
cells (white blood) see also "leukocytes" and "lymphocytes" 1-86, 1-90, 1-121

cellulose
cellulose 8-95
cellulose acetate 1-165
cellulose paper (see also "paper") 3-3

ceramic (see also "Ceramics" in the Key Words Index)
ceramic 14-145, 14-148
ceramic discs 1-140, 1-144, 1-148
ceramic microsphere solid tracers (see also "spheres" and "tracer...") 2-28
ceramic plates (vitreous-silica) see also "silica" 17-217
ceramic powders 18-220, 18-224
ceramic tracers 2-58

cerium see "Ce*"

cerrelow (lead and bismuth), 4-55

cerrobend-coated beryllium copper fibers (see also "fiber") 5-10

cesium see "Cs*"

chameleon skin 1-128

chloric/chloride/chlorine (for the majority of the listings see "Cl*")
chloride (ammonium) 14-19, 14-23, 14-26
chloride (nickel) 17-199
chloride (silver/silver) 15-26
chloride (sodium) see also "Na*Cl*" 2-58, 7-17, 7-21, 9-27, 9-31, 16-31
chloride solution (potassium) see also "K*Cl*" 15-26
chloride-tris buffer (see also "buffer") 1-17
chlorine-doped cadmium telluride (see also "Cd*Te*Cl*") 8-88
hydrochloric acid 2-9

chloroform 8-67

chromatography paper (wick material) see also "paper" and "wicks" (this index) and (1) "High Performance Liquid Chromatography" and (2) "Wicking" (in the Key Words Index) 18-156, 18-159

chrome film (see also "film" (this index)) 10-46

chromium see "Cr*"

Cl* (listed as the primary element) see "chloric/chloride/chlorine"
(no other listings)

Cl* (listed as a secondary element) see also "chloric/chloride/chlorine"
Ag*Ag*Cl* 15-26
Ag*Cl* 15-26
Ca*Cl* 8-17
Cd*Te*Cl* 8-88
Cs*Cl* 14-116
Ge*Cl* 10-46
Hg*Cl* 8-92
K*Cl* 1-78, 1-113, 15-26
N*H*Cl* (ammonium chloride) 14-19, 14-23, 14-26
N*H*Cl*H*O* 9-45, 9-48
Na*Cl* 1-29, 1-78, 2-58, 7-17, 7-21, 9-27, 9-31, 15-78, 16-31
Ni*Cl* 17-199
Pb*Cl* 8-17
Zn*Cl* 18-19

cloth wick (see also "wicks") 2-13

CMF-PBS (see also "buffer") 1-78

Co* (listed as the primary element) see also "cobalt"
Co* 15-81
Co*Cr*C* 15-81
Co*Sm* 14-163
Co*W*C* 13-11

Co* (listed as a secondary element) see also "cobalt"
Ce*Cu*Co* 17-22
Cu*Co* 13-21
Cu*Ti*Co* 14-73
Cu*Ti*Co*Ti* 14-73
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Fe*W*Co* 13-6
Sn*Co* 11-62
W*C*Co* 5-124

coated materials/coating (see also "plated" (this index) and (1) "Plating" and (2) the "Coated..." titles (in the Key Words Index)
coated beryllium copper fibers 5-10
coated fibers (see also "fiber") 5-10, 5-113
coated filament 10-46, 10-72
coated nylon fabric 3-3
coated sample 6-57, 9-121, 13-3
coated spheres (see also "spheres") 5-3, 5-7
coated tungsten 5-3, 5-7
coating (aluminum) 10-46, 10-72
coating (argon and copper) 5-7
coating (cerrobend) 5-10
coating (copper) 5-3, 5-7, 13-3
coating (gold) 10-46
coating (neoprene) 3-3
coating (silica) see also "silica" 9-121
coating (silicon monoxide) 10-46
coating (silver) 13-3

cobalt (for the majority of the listings see "Co*")
cobalt-tungsten carbide (see also "W*C*Co*") 5-124

collagen
collagen initiation buffer (see also "buffer") 1-135
collagen (solubilized) 1-135

colored proteins (see also "protein" and "dye") 1-17, 1-22, 1-26

composites see the "Composites..." titles in the Key Words Index

concanavalin (see also "canavalin")
con A (see also "concanavalin A") 1-90
concanavalin A 1-86, 1-90
concanavalin-B 16-37, 16-42

copper (for the majority of the listings see "Cu*")
copper-beryllium fibers 5-10
copper braid 18-37
copper clad 18-31
copper-coated boron carbide spheres (see also "Cu*B*C*" and "spheres") 5-3
copper-coated tungsten spheres (see also "Cu*W*" and "spheres") 5-3, 5-7
copper coating 5-3, 13-3
copper containing alumina particles (see also "Cu*Al*O*" and "alumina particles") 5-76, 5-79, 5-82, 5-85
copper containing molybdenum particles (see also "Cu*Mo*" and "molybdenum particles") 5-76, 5-79, 5-87, 5-140, 18-108
copper (electrolytic) 15-26
copper phthalocyanine 10-57, 10-62
copper powder 18-105, 18-108
copper sulfate (see also "Cu*S*") 15-3, 18-212
copper tubes 18-19
copper wire 8-7, 18-34
copper with silicon carbide particles (see also "Cu*Si*C*" and "particles") 5-14

coreless solder (see also "solder") 18-22, 18-25, 18-58

cotton swab 15-5

Cr* (chromium) listed as the primary element
Cr* (chrome film) 10-46

Cr* (chromium) listed as a secondary element
Co*Cr*C* 15-81
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12

cream (whipped) 1-14

crude oil (see also "oil") 17-155

Cs* (cesium) listed as the primary element
Cs*Cl* 14-116

Cs* (cesium) listed as a secondary element
no listings

Cu* (listed as the primary element) see also "copper"
Cu* 4-22, 5-3, 5-22, 5-126, 8-7, 10-57, 13-3, 15-22, 15-24, 15-26, 18-19, 18-31, 18-34, 18-37
Cu*Ag*Ti* 18-15
Cu*Al*O* 5-22, 5-29, 5-76, 5-79, 5-82, 5-85, 5-121, 5-126, 18-105
Cu*B*C* 5-3
Cu*Co* 13-21
Cu*Fe* 13-21
Cu*Mo* 5-22, 5-26, 5-29, 5-76, 5-79, 5-87, 5-126, 5-140, 18-108

Cu*O*C* 4-24
Cu*Pb* 17-95
Cu*S* 15-3, 18-212
Cu*Si*C* 5-14, 5-22, 5-29
Cu*Si*O* 5-18, 5-26
Cu*Sn*Cu*O*C* 4-38
Cu*Ti* 14-73
Cu*Ti*Al*Ti* 14-73
Cu*Ti*Al*V* 14-73
Cu*Ti*B* 14-73
Cu*Ti*Co* 14-73
Cu*Ti*Co*Ti* 14-73
Cu*Ti*Fe* 14-73
Cu*Ti*Fe*Ti* 14-73
Cu*Ti*Fe*Zr* 14-73
Cu*Ti*Ni* 14-73
Cu*Ti*Ni*Ti* 14-73
Cu*Ti*Ni*Zr* 14-73
Cu*Ti*Si* 14-73
Cu*Ti*Si*Ti* 14-73
Cu*Ti*Si*Zr* 14-73
Cu*W* 5-3, 5-18, 5-22, 5-29, 13-21
Cu*Zn* 18-28

Cu* (listed as a secondary element) see also "copper"
Ag*Cu* 4-47
Ag*Cu*Al*O* 4-47
Ag*Cu*Li* 18-3, 18-8, 18-12
Ag*W*Ni*Cu* 5-95
Al*Cu* 5-69, 5-72, 11-86, 14-8, 14-11, 14-35, 14-46, 14-57, 14-65, 14-69, 14-82, 14-85, 14-89, 14-93, 14-114, 14-150
Al*Cu*Al* 14-82, 14-85
Al*Cu*Al*O* 5-69, 5-72
Al*Pb*Si*Cu*Sn* 17-56
Au*Ag*Cu* 18-12
Be*Cu* 5-10
Ce*Cu* 6-3
Ce*Cu*Co* 17-22
In*Bi*Be*Cu* 5-10
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Cu* 6-3
Ni*Cu*Al* 11-89
Ni*Cu*Au* 11-89
Pb*Cu* 17-80
Pd*Cu*Si* 6-48, 6-52, 6-54, 18-71, 18-73
Pd*Si*Cu* 6-48, 6-52, 18-67
W*Cu* 13-13
Zn*Bi*Cu* 17-99

cyanobacterium photosystem 1 complex 16-58

cyclohexane/cyclohexanol (see also "n-hexanol") 7-24, 7-27, 17-146, 17-152
cyclohexane (deuterated) 7-27
cyclohexane (deuterated) with methanol) 7-24
cyclohexanol-fluorescein (see also "C*H*O*") 9-41

cyclosporin A-cyclophilin complex 16-58

cylinders (glass) suspended in an experiment chamber (see also "glass") 15-57

Cytodex 3 microcarrier beads (see also "beads") 1-78

D

d-camphor 5-62, 5-66

desalinated water (see also "water") 2-21, 2-24

detergent (see also "soap") 17-199

deuterated cyclohexane (see also "cyclohexane") 7-27

deuterated cyclohexane and methanol (see also "cyclohexane") 7-24

devitrified glass (see also "glass") 6-35, 6-39

dextran/dextrose
dextran 1-95, 1-157, 1-161
dextran/polyethylene glycol (PEG) (see also "polyethylene glycol") 1-95
dextrose 1-17, 1-29

diacetinase 16-53, 16-58

diamond
diamond dust 15-81
diamond composite 5-116

dilute borate (see also "borate" and "H*B*O*Na*N*O*H*") 1-6

dimethyl... (see also "methyl...")
dimethyl silicone oil (see also "oil" and "silicone oil") 2-33, 2-52, 2-54
dimethyl siloxane 2-37
dimethyl sulfoxide (DMSO) 1-10

di-n-octyl phthalate 12-175

d-octyl phthalate 12-222

dispersion alloys see "Dispersion Alloys" in the Key Words Index

distilled.../distilled water
distilled water (see also "water") 1-29, 2-58, 12-3, 12-82, 12-86, 12-90, 12-93, 12-96, 12-233, 12-289, 17-199
vacuum <u>distilled</u> perfluoraolkyl polyether 18-215

disulfone magenta (DSM) (see also "polysulfone") 8-67

DNA 1-3, 16-25, 16-58
DNA (salmon sperm) 1-3
DNA (synthetic fragment) 16-25
DNA (12-base pair) 16-58

Dow Corning FC-10 (an antifoam ingredient) see also "foam" (this index) 12-256

Dulbeco's Modified Eagle Medium (see also "medium") 1-78

dye (see also "colored proteins," "ink," "paint," and "stain")
dye/dyed fluid 1-3, 1-61, 1-157, 1-161, 2-9, 2-65, 6-35, 6-39, 7-31, 8-67, 11-95, 12-27, 12-46, 12-256
dye (blue food coloring) see also "blue" 12-256
dye (grape drink/juice) 12-27, 12-46
dye (ink, marker pen) 12-46
dye (liquid dye laser) 18-244
dye (methylene blue) see also "blue" 8-67
dye (oil mixed with blue dye) see also "blue" and "oil" 12-53
dye (protein) (see also "colored proteins") 1-61, 1-65
dye (strawberry drink) 12-46
dye (thymol blue) see also "blue" 2-9
dye (trypan blue) see also "blue" 1-157, 1-161, 2-65, 11-95, 17-199
dyed water (see also "water") 9-39, 12-24, 12-46, 12-53, 12-82, 12-86, 12-90, 12-93, 17-14, 17-199, 18-156, 18-159

Dynamic Random Access Memory (DRAM) Chips 18-247

E

Eccosphere/Echosphere (see also "glass," "particles," "spheres," and "tracer particles")
Echosphere glass tracer particles 12-217, 12-222, 12-243
Eccosphere tracer particles 2-33

EDTA 1-78

egg
egg albumin (see also "albumin") 1-43, 1-48
egg white lysozyme (hen) (see also "lysozyme") 16-42

elastomer-modified epoxy resins (see also "epoxy resin") 17-230

electrodes see "Electrodes" in the Key Words Index

electrolyte/electrolytic (see also "Electrolysis" and "Electrolyte Solution" in the Key Words Index)
electrolyte (copper sulfate solution) 18-212
electrolyte (K*Cl* solution) 15-26
electrolyte (Na_2SO_4 water solution) 15-22, 15-24
electrolyte (Ni-sulfamate) 15-10, 15-13
electrolyte (Ni-sulfate) 15-16, 15-19
electrolytic copper 15-26

engineered cell line (see "cell")

epoxy
epoxy-capped elastomer 17-230
epoxy resins (see also "resin") 5-109, 17-230

erythrocytes (see also "cells (red blood)") 1-10, 1-17, 1-29, 1-35, 1-41, 1-121
erythrocytes (guinea pig) 1-41
erythrocytes (horse) 1-29
erythrocytes (human) 1-10, 1-17, 1-29, 1-35, 1-121
erythrocytes (rabbit) 1-10, 1-29, 1-35, 1-41
erythrocytes (rat) 1-41

erythropoietin 1-57, 1-61, 1-65

ethane (C_2H_6) (see also "C*H*") 18-169

ethanol (see also "alcohol" and "triethanolamine-potassium acetate") 11-91, 12-311, 12-316, 14-137, 14-141, 15-72, 17-199

ethyl alcohol (see also "alcohol") 2-9

ethylenediaminetetraacetic acid 1-29

Eu* (europium) listed as the primary element
Eu*La* 17-210

Eu* (europium) listed as a secondary element
no listings

europium see "Eu*"

eutectics see "Eutectics" in the Key Words index

eutectic salt (see also "salt" (this index) and "Eutectics" in the Key Words Index) 9-27, 9-31

evacuolated protoplasts (see also "protoplasts") 1-125

F

F* (listed as the primary element) see also "fluor..."
no listings

F* (listed as a secondary element) see also "fluor..."
C*F* 10-62
Li*F* (lithium fluoride) 9-31
Na*F* (sodium fluoride) 9-27
S*F* 7-3, 7-5, 7-8, 7-11, 7-33, 7-36
Zr*F*Ba*F*La*F* 6-44

faceted eutectics see "Faceted Eutectics" in the Key Words Index

Fe* (listed as the primary element) see also "iron"
Fe* 14-101, 14-197
Fe*C*Al*Si*O* 4-32
Fe*C*Si*O* 4-32, 4-35
Fe*C*Si*P*S* 14-101
Fe*C*Si*S* 18-116
Fe*N* 4-29
Fe*Ni*P*B* 6-21
Fe*P*N* 4-35

Fe* (listed as a secondary element) see also "iron"
Cu*Fe* 13-21
Cu*Ti*Fe* 14-73
Cu*Ti*Fe*Ti* 14-73
Cu*Ti*Fe*Zr* 14-73
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Fe*W*Co* 13-6
W*Ni*Fe* 13-18

feed material see "Feed Material" in the Key Words Index

ferrite (see also "Fe*" and "iron") 14-101

ferritin 1-17

Ferro brand EG-0222 silicate glass (see also "glass" and "silicate") 6-57

fetal bovine serum (see also "albumin," "bovine," and "serum") 1-78

fiber (see also the "Fiber..." titles in the Key Words Index)
fiber 4-3, 5-10, 5-113, 5-118, 5-130, 5-132, 5-135, 18-252
fiber (alumina) 5-118, 5-130, 5-132, 5-135
fiber (carbon) 5-113
fiber (coated) 5-10, 5-113
fiber (silver) 4-3
fiber/slurry mixture 18-252

fibrigen solution 1-152

Ficoll 1-95

filament
filament (coated) 10-46, 10-72
filament coated with aluminum and silicon monoxide 10-46
filament coated with aluminum 10-46
filament coated with gold 10-46
filament (tungsten) 10-72, 18-129

film see also the "Film..." titles in the Key Words Index
film (chrome) 10-46
film (gold) 10-46
film (thin, metal-free phthalocyanine) 10-57, 10-62
film (silver) 10-46

flakes (see also "particles" and "tracer...")
flakes 12-13, 12-184, 14-101
flakes (aluminum) 12-184

flakes (graphite)   14-101
flakes (tracer)   12-13

fluor... (see also "Heavy Metal Fluoride Glasses" in the Key Words Index)
cyclohexanol fluorescein   9-41
green fluorescent protein   16-25, 16-53
fluoride glass (see also "glass")   6-44
fluorocarbon blowing agent   4-57
fluorochemical (inert)   12-7
lithium fluoride (Li*F*)   9-31
perfluoraolkyl polyether   12-18, 18-215
perfluorinated hydrocarbon   12-213
perfluorotributylamine   12-7
sodium fluoride (Na*F*)   9-27
sulfur hexafluoride (S*F*)   7-5, 7-8, 7-11, 7-33, 7-36

fluorine see "F*"

flux (see also "Flux" in the Key Words Index)
flux   18-31, 18-34, 18-37
fluxing agent   18-19

foam (see also the "Foam..." titles in the Key Words Index)
antifoaming ingredient   12-256
foam (metallic) see "Metallic Foams" in the Key Words Index
foam (polyurethane)   4-57
foam (soap)   12-30
foaming gas (see also "gas")   2-26

folic acid (see also "acid") 1-78

formaldehyde   2-6

Freon
Freon   15-44
Freon 11   18-144, 18-173
Freon-21   18-144, 18-149
Freon 113   2-62, 12-252, 15-30, 15-32, 15-36, 15-39, 15-41
Freon R113   15-49

fuel cell screening (see also "screen")   2-62

G

G8 hybridoma (see also "hybridoma")   1-118

Ga* (listed as the primary element) see also "gallium"
Ga*As*   9-51, 9-54, 9-149, 9-153, 10-3
Ga*Ge*   9-14, 9-98
Ga*Hg*   17-159, 17-163
Ga*O*Ca*O*   6-35, 6-39
Ga*O*Ca*O*Si*O*   6-28, 6-32, 6-35, 6-39
Ga*Sb*   8-38
Ga*Sb*Te*   8-38, 8-42

Ga* (listed as a secondary element) see also "gallium"
Ge*Ga*   9-34, 9-69, 9-73, 9-98, 9-101, 9-104, 9-106, 9-109, 9-156
In*Ga*Sb*   9-19, 9-25
Te*Ga*Sb* (tellurium-doped GaSb)   8-38

gallia-calcia glass (see also "glass")   6-28, 6-32

gallium (for the majority of the listings see "Ga*")
gallium-doped germanium (see also "Ge*Ga*")   9-34, 9-69, 9-73, 9-101, 9-104, 9-106, 9-109, 9-156

gamma-interferon (see also "interferon") 16-48, 16-58

gap filler material (see also "Gap Filling" in the Key Words Index) 18-8, 18-12, 18-19

gas (see also "air" (this index) and the "Gas..." titles in Key Words Index)
gas 17-199
gas bubble(s) 6-35, 6-39, 12-294, 12-321, 14-116
gas (buffer) 10-20, 10-24, 10-57, 10-62
gas (control (N*)) 10-62, 18-139, 18-162
gas (foaming) 2-26
gas (inert mixture: krypton/helium) 6-25, 18-64

Ge* (listed as the primary element) see also "germanium"
Ge* 10-68
Ge*B* 9-34
Ge*Cl* 10-16
Ge*Ga* 9-34, 9-69, 9-73, 9-98, 9-101, 9-104, 9-106, 9-109, 9-156
Ge*Ge*I* 10-68
Ge*I* 10-7, 10-12, 10-16, 10-68
Ge*S* 10-16
Ge*S*Se* 10-16
Ge*Sb* 9-34
Ge*Se* 10-7, 10-12, 10-20, 10-24
Ge*Se*Te* 10-16
Ge*Te* 10-7, 10-12

Ge* (listed as a secondary element) see also "germanium"
Ag*Ge* 14-89, 14-124, 14-126
Al*Ge* 14-124, 14-126
Au*Ge* 17-6, 17-11
Ga*Ge* 9-14, 9-98

gel media 8-34

gene
gene (human nuclear t-RNA) 16-25
gene transfer media 1-113

germanium (for the majority of the listings "Ge*")
germanium doped with antimony (see also "Ge*Sb*") 9-34
germanium doped with boron (see also "Ge*B*") 9-34
germanium doped with gallium (see also "Ge*Ga") 9-34, 9-69, 9-73, 9-101, 9-104, 9-106, 9-109, 9-156
germanium tetraiodide 10-16

glass (see also the "Glass..." titles in the Key Words Index)
glass 1-165, 1-170, 5-57, 5-62, 5-66, 6-28, 6-32, 6-35, 6-39, 6-44, 6-57, 11-24, 11-28, 11-52, 12-167, 12-217, 12-222, 12-243, 17-59, 17-66, 17-69, 17-72, 18-215
glass beads (see also "beads") 5-57, 5-62, 5-66, 17-199
glass composite 14-145
glass cylinders 15-57
glass (devitrified) 6-35, 6-39
glass discs 1-140, 1-148
glass (echosphere) see also "spheres" 12-217, 12-222, 12-243
glass (fluoride) 6-44
glass (gallia-calcia) 6-28, 6-32
glass (heavy metal fluoride) see also "metal" (this index) and "Heavy Metal Fluoride Glasses" in the Key Words Index 6-44
glass (particles) 17-59, 17-63, 17-66, 17-69, 17-72
glass (metallic) see "Metallic Glasses" in the Key Words Index

glass (silicate) see also "silicate" 6-57
glass (silver-sodium) see also "Ag*Na*" 17-66, 17-69, 17-72
glass (Si*O*Na*O*Al*O*) 11-52
glass (soda-lime silica) see also "silica" and "soda-lime..." 5-57, 11-28
glass (sodium-borate) 12-167

glucose 1-29, 1-121

glue 1-14

glutaraldehyde 1-90, 1-128, 1-135, 1-152

glutaraldehyde fixative 1-78

glycerin/glycerol
glycerin 12-109
glycerin/water mixtures 12-98
glycerol 1-29

gold (for the majority of the listings see "Au*")
gold cathode 15-10, 15-13, 15-16
gold coating 10-46
gold filament 10-46
gold film 10-46

grape drink/grape juice (see also "dye") 12-27, 12-46

graphite
graphite (epoxy-resin) 5-109
graphite flakes 14-101
graphite plates 17-217

green fluorescent protein (see also "protein") 16-25, 16-53

grey cast iron (see also "Fe*," "Fe*C*Si*P*S*" and "iron") 14-101

grey iron (see also "Fe*" and "iron") 18-116

guinea pig erythrocytes (see also "cell") 1-41

H

H* (listed as the primary element) see also "hydrogen"
H*B*O* 8-92
H*B*O*Na*N*O*H* 1-6
H*O* (see also "water") 8-81
H*S*O* 8-27, 8-48, 8-74

H* (listed as a secondary element) see also "hydrogen"
Al*Ti*H* (aluminum with titanium hydride) 4-41
C*Br*H* 12-60
C*H* (ethane) 18-169
C*H*C*S*N*H* 8-17
C*H*O* 5-62, 5-66, 9-41, 12-162
C*H*O*Ni* 5-62, 5-66, 9-41, 12-162
Ca*C*H*O* 8-12, 8-48
Ca*N*O*N*H*H*P*O* 8-34
K*H*P*O* 1-29, 1-78, 1-113, 8-30
K*Pt*C*N*H*O* 8-55, 8-58
N*H* (see also "ammonia") 1-14, 18-139, 18-144, 18-153, 18-162, 18-173, 18-178, 18-184
N*H*C*H*C*O*H* 8-27, 8-74
N*H*Cl* 14-19, 14-23, 14-26
N*H*Cl*H*O* 9-45, 9-48
N*H*H*C*O* 8-17
N*H*Pt*C*O* 8-48
Na*H*C*O* 1-78
Na*H*P*O* 1-29, 1-78
Na*O*H* 1-140
Ni*N*H*S*O* 15-10, 15-13
Pb*C*H*O* 8-95
Pb*N*O*H*P*O* 8-34

halogen lamp (see also "lamps" (this index) and "Halogen Lamps" in the Key Words Index) 18-129, 18-135

hardwood kraft pulp 18-252

He* (helium) 6-25, 10-57, 10-62, 11-28, 12-271, 12-275, 18-64
He* bubble 11-28
He* (superfluid) 12-271, 12-275
Kr*He* 6-25, 18-64

heavy metal fluoride glass (see also "glass," "fluor..." and "metal...") 6-44

HEK cells (see also "cell") 1-78

helium see "He*"

hemoglobin (see also "cell" and "protein" (this index)) 1-3, 1-17, 1-22, 1-26, 1-48, 1-61

hen egg white lysozyme (see also "lysozyme") 16-42

HEPES 1-78

heptane 8-67
n-heptane 18-169
n-heptanol 12-194, 12-198

HES-hydroxyethyl starch 1-86

hexadecane (see also "n-dodecane") 17-199

Hg* (listed as the primary element) see also "mercury"
Hg* 12-213, 16-15
Hg*Br* 8-92
Hg*Cd*Te* 9-144
Hg*Cl* 8-92
Hg*I* 8-92, 10-38, 10-43, 10-51

Hg (listed as a secondary element) see also "mercury"
Cd*Hg*Te* 9-144
Ga*Hg* 17-159, 17-163

highly reactive materials see "Highly Reactive Materials" in the Key Words Index

high speed steel supersaturated with nitrogen (see also "steel" (this index) and "Supersaturation" in the Key Words Index) 4-29

high stiffness composites see "High Stiffness Composites" in the Key Words Index

high temperature materials see "High Temperature Materials" in the Key Words Index

hormone
hormone (human growth) 16-53, 16-58
hormone (melanocyte stimulating) (MSH) (see also "hormone") 1-128

horse red blood cells (see also "cells") 1-29

horse spleen ferritin (see also "spleen" (this index)) 1-17

human...
human C-reactive protein-CRP (see also "protein") 16-25, 16-31, 16-37, 16-42, 16-48
human embryonic (or fetal) kidney cells 1-29, 1-73
human erythrocytes (see also "cells") 1-10, 1-17, 1-29, 1-35, 1-121
human growth hormone (see also "hormone") 16-53, 16-58

human hemoglobin (see also "hemoglobin") 1-17
human kidney cells 1-10, 1-29, 1-73
human lymphocytes (see also "lymphocytes") 1-29, 1-86, 1-90
human nuclear t-RNA gene 16-25
human purine nucleoside (see "purine nucleoside")
human red blood cells (see also "erythrocytes") 1-10, 1-17, 1-29, 1-35, 1-121
human serum 1-86, 1-90
human serum albumin (see also "albumin") 1-65, 16-42, 16-48, 16-58
human serum transferrin 16-25
human somototropin 16-53

hybridoma
hybridoma cell line (see also "cell") 1-113
hybridoma clone (SP2/0-UZ) 1-118
hybridoma (G8) 1-118
Hybridoma Strain (see also "strains") 1-113

hydrazine 18-234

hydrochloric acid (see also "acid") 2-9

hydrogen (for the majority of the listings see "H*" (this index); in addition, see "Hydrogen Formation" in the Key Words Index)
hydrogen ammonium phosphate (see also "ammonium" and "phosph...") 8-34
hydrogen-saturated carbon tetrabromide (see also "C*Cr*H*") 12-60
potassium-di<u>hydrogen</u> phosphate (see also "K*H*P*O*") 8-30

hydroxyethyl starch 1-86

hypereutectics see "Hypereutectics" in the Key Words Index

hypermonotectic compositions see "Hypermonotectics" in the Key Words Index

hypoeutectics see "Hypoeutectics" in the Key Words Index

<u>I</u>

I* (listed as the primary element) see also "iodide/iodine"
I*K*I* 11-74

I* (listed as a secondary element) see also "iodide/iodine"
Ag*I* 10-28, 10-33
Ge*I* 10-7, 10-12, 10-16, 10-68
Ge*Ge*I* 10-68
Hg*I* 8-92, 10-38, 10-43, 10-51
K*I* 8-95
Na*I* 8-105

ice see "water" (this Index) and "Ice" in the Key Words Index

Igebal CO-710 detergent (see also "soap") 17-199

i-inositol (see also "inosite") 1-78

immiscible alloys see "Immiscible Alloys" in the Key Words Index

immiscible fluids see "Immiscible Fluids" in the Key Words Index

impurities see "Impurities" in the Key Words Index

In* (listed as the primary element) see also "indium"
In* 12-71, 12-74
In*Bi* 5-3, 5-7
In*Bi*Be*Cu* 5-10
In*Bi*Si*C*Ar* 5-7
In*Ga*Sb* 9-19, 9-25
In*P*S* 8-45
In*Pb* 12-71, 12-74
In*Sb* 6-8, 6-13, 9-5, 9-9, 9-134, 14-145, 14-148
In*Sb*Ni*Sb* 14-128, 14-131, 14-134
In*Sb*Se* 6-13
In*Sb*Sn* 9-5, 9-9, 9-134
In*Sb*Te* 9-3, 9-5, 9-9
In*Tl* 9-112

In* (listed as a secondary element) see also "indium"
Al*In* 17-34, 17-38, 17-43, 17-48, 17-51, 17-75, 17-139, 17-181, 17-186, 17-196
Pb*Sn*In* 17-6, 17-11
Sn*In* 11-70

IN 100 (nickel-based alloy) (see also "Alloys" in the Key Words Index) 18-77, 18-82

IN-738 (nickel based alloy IN-738 containing approximately 0.1 micron Y_2O_3 dispersed particles (see also "Ni*," "Ni*Y*O*," and "particles")) 18-82

Incoloy 18-15

indium (for the majority of the listings see "In*")
indium antimonide doped with tin (see also "In*Sb*Sn*") 9-134
indium antimonide doped with selenium (see also "In*Sb*Se*") 6-13
indium antimony doped with tellurium (see also "In*Sb*Te*") 9-3, 9-5
indium antimony doped with tin (see also "In*Sb*Sn*") 9-5
indium bismuth eutectic powder 5-3
indium doped with thallium (see also "In*Tl*") 9-112
indium phosphide doped with sulfur (see also "In*P*S*") 8-45

inert fluorochemical 12-7

inert gas mixture (krypton/helium) 6-25, 18-64

influenza virus (see also "virus") 16-25

ink (see also "dye") 12-46

inorganic crystals see "Inorganic Crystallization" in the Key Words Index

Inosite (see also "i-inositol") 1-113

insoluble crystals see "Insoluble Crystals" in the Key Words Index

integrated circuit (see also "printed circuit board") 18-43

interferon 16-25, 16-31, 16-37, 16-48, 16-53, 16-58
interferon (alpha2) 16-25, 16-31, 16-37
interferon (gamma) 16-48, 16-58

intermetallics see "Intermetallics" in the Key Words Index

iodide/iodine (for the majority of the listings see "I*")
iodide (an antibacteria agent) 12-256
germanium tetraiodide 10-16
mercury iodide (see also "Hg*I*") 10-38, 10-43, 10-51
potassium iodide 8-95, 11-74
silver iodide (see also "Ag*I*") 10-28, 10-33, 11-74
sodium iodide (see also "Na*I*") 8-105

ionic solution see "Ionic Solution" in the Key Words Index

iriodine (a tracer) 12-233

iron (for the majority of the listings see "Fe*")
iron (cast) 17-97, 14-101
iron (grey cast) 14-101
iron (grey) 18-116
iron (white cast) 14-97

Isobutyric acid-water system 7-31

isocitrate lyase 16-48, 16-58, 16-53

<u>J</u>

jellies 1-14

joint material (see also "Gap Filling" in the Key Words Index) 18-3

<u>K</u>

K* (listed as the primary element) see also "potassium"
K* 15-53
K*Al*S* 8-81
K*Cl* 1-78, 1-113, 15-26
K*Cl* solution which was saturated with oxygen 15-26
K*H*P*O* 1-29, 1-78, 1-113, 8-30
K*I* 8-95
K*Pt*C*N*H*O* 8-55, 8-58

K* (listed as a secondary element) see also "potassium"
I*K*I* 11-74

KBI HIP-50 alloy (see also "Alloys" in the Key Words Index) 6-17

Kearfott 2412 accelerometers (see also "accelerometers") 18-231

kidney cells see "human kidney cells" or "cells"

Krypton (Kr*)
Kr*He* 6-25, 18-64

Krytox oil (see also "oil")
Krytox 143AZ oil 12-18, 17-14
Krytox 143AA oil 12-18
Krytox oil 2-3, 12-13, 12-184, 17-199

L

La* (lanthium)
Eu*La* 17-210
Zr*F*Ba*F*La*F* 6-44

LAC repressor/operator see "repressor/operator"

lamellar eutectics see "Lamellar Eutectics" in the Key Words Index

lamps (see also "Halogen Lamps" and "Metal Halide Arc Lamps" in the Key Words Index) 18-129, 18-131, 18-135

lanthium see "La*"

laser (see also the "Laser..." titles in the Key Words Index) 18-244

latex (see also "Monodisperse Latex Particles" and "Polystyrene Latex Microspheres" in the Key Words Index) 1-53, 12-194, 12-198, 12-201, 18-189, 18-195, 18-199, 18-203, 18-207
latex particles (see also "particles") 12-194, 12-198
latex tracer particles (see also "tracer particles") 12-201

lead (for the majority of the listings see "Pb*")
lead acetate (see also "acetate" and "Pb*C*H*O*") 8-95
lead-alkali-silicate glass beads (see also "alkali silicate," "beads," "glass" and "silicate") 5-57
lead and bismuth (cerallow) 4-55
lead monetite 8-34
lead nitrate 8-34
lead sulfide (see also "Pb*S*") 8-12

lectin 16-25, 16-53, 16-58
lectin (wisteria) 16-25

leukocytes (see also "cells" and "cells (white blood)") 1-121

LGAS (Low-G Accelerometer System) (see also "accelerometers") 18-231

Li* (listed as the primary element) see also "lithium"
Li*F* (lithium fluoride) 9-31
Li*N*O* 8-92
Li*O*Si*O* 11-40
Li*O*Si*O*Pt* 11-40

Li* (listed as a secondary element) see also "lithium"
Ag*Cu*Li* 18-3, 18-8, 18-12

linen painted with oil colors (see also "oil" and "paint") 18-241

liquid dye laser 18-244

liquid films see "film" (this Index) and the "Liquid Film..." titles in the Key Words Index

liquid lubricants 18-215

lithium (for the majority of the listings see "Li*")
lithium fluoride 9-31

lymphocytes (see also "cells" and "cells (white blood)") 1-29, 1-86, 1-90, 16-65
lymphocytes (human) 1-29, 1-86, 1-90
lymphocytes (T-helper) 16-65
lymphocytes (T-suppressor) 16-65

lysozyme 16-12, 16-22, 16-25, 16-31, 16-37, 16-42, 16-58, 16-70

M

magnesium (for the majority of the listings see "Mg*")
magnesium particles (see also "particles") 12-18

magnetic composites see "Magnetic Composites" in the Key Words Index

malachite 7-31

mammalian strains (see also "strains") 1-118

manganese see "Mn*"

marker pen ink (see also "dye") 12-46

mayonnaise 1-14

MEA Accelerometer Package (see also "accelerometers") 18-231

media/medium
media (cell fusion) 1-113, 1-118
media (gel) 8-34
media (gene transfer) 1-113
media (proprietary tissue/cell culture) 1-43, 1-48, 1-53
media (tissue culture) 1-48, 1-53
Medium 199 1-78
medium (cell culture RPMI1640) 1-86, 1-90
Medium (Dulbeco's Modified Eagle Medium) 1-78

mediflor 12-213

melanocyte stimulating hormone (MSH) (see also "hormone") 1-128

MEM alpha 1-78

membranes see "Membranes" in the Key Words Index

METGLAS 2826 6-21

mercury (for the majority of the listings see "Hg*")
mercury 12-213
mercury iodide (see also "Hg*I*") 10-38, 10-43, 10-51
mercury (organic compound containing mercury) 16-15

metal/metallic (see also "powders" (this index) and the "Metal..." titles in Key Words Index)
metal (braze) 18-15
metal halide arc lamps (see also "lamps") 18-131
metal (heavy metal fluoride glass) 6-44
metal (pure, dissolved in liquid aluminum) 14-69
metallic foams
see "Metallic Foams" in the Key Words Index
metallic glasses
see "Metallic Glasses" in the Key Words Index
metallic matrix
see "Metallic Matrix" in the Key Words Index
metallic oxides
see "Metallic Oxides" in the Key Words Index
metallic powders (see also the "Powder..." and "Metal..." titles in the Key Words Index) 5-3, 12-18, 12-135, 12-187, 12-190, 13-3, 13-18, 18-105, 18-108, 18-220, 18-224

metallic solutions
see "Metallic Solutions" in the Key Words Index

metals see "Metal/Metallic," "Metals," and "Metals and Alloys" in the Key Words Index

methanol (methyl alcohol CH_3OH) see also "alcohol")
1-148, 7-24, 7-27, 8-63, 8-67, 12-135, 17-146, 17-152
methanol with deuterated cyclohexane 7-24

methyl... (see also "dimethyl...")
methyl alcohol (see "methanol")
methyl green 17-199
methylenbromid 12-264
methylene blue dye (see also "dye") 8-67
methylimidazole 17-230
methylpentanediol 16-31

Mg* (listed as the primary element) see also "magnesium"
Mg-acetate 1-113
Mg*Th*Mg*O* 5-52
Mg*Th*O* 5-48

Mg* (listed as a secondary element) see also "magnesium"
Al*Mg* 4-19, 14-159, 18-86, 18-89, 18-92
Ce*Mg* 9-79, 9-81
Zn*Bi*Mg* 17-99

microcarrier beads (see also "beads") 1-78

microspheres see "spheres"

milk 1-14

milk of magnesia 1-14

mitogen 1-86, 1-90

Mn* (manganese) listed as the primary element
Mn*Bi* 17-22, 17-30, 17-120, 17-125, 17-128

Mn* (manganese) listed as a secondary element
Bi*Mn*Bi* 17-26, 17-133, 17-136, 17-175
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12

Mo* (listed as the primary element) see also "molybdenum"
Mo* powder 18-220, 18-224

Mo* (listed as a secondary element) see also "molybdenum"
Al*Mo* 14-69
Cu*Mo* 5-22, 5-26, 5-29, 5-76, 5-79, 5-87, 5-126, 5-140, 18-108
Ni*Al*Mo* 18-99, 18-111
Ni*Mo*Ti*C* 5-99, 5-104, 5-106

model materials see "Model Materials" in the Key Words Index

molten salt see "salt" (this index) and "Molten Salts" in the Key Words Index

molybdenum (for the majority of the listings see "Mo*")
molybdenum-nickel alloy with titanium carbide particles (see "Ni*Mo*Ti*C*") 5-99, 5-106
molybdenum-nickel alloy with titanium carbide whiskers (see also "Ni*Mo*Ti*C*") 5-99
molybdenum particles (see also "particles") 5-22, 5-76, 5-79, 5-87, 5-126, 5-140, 18-108

monodisperse latex particles see "latex" and "particles" (this index) and "Monodisperse Latex Particles" in the Key Words Index

monoclonal antibody see "antibody"

monosodium aspartate (see also "sodium") 16-22

monotectic compositions see "Monotectic Compositions" in the Key Words Index

mucopeptide N-acetylmuramoylhydrolase (see also "acetate...") 16-12

multi-core solder (see also "solder") 18-25

multiphase media see "Multiphase Media" in the Key Words Index

Myeloma Strain Sp2 + pSV2-neo Plasmid (see also "strains") 1-113

Myeloma strain SP2 X G8 Hybrid Hybridoma Strain (see also "strains") 1-113

N

N* (listed as a primary element) see also "nitrogen"
N* (control gas) 10-62, 18-139, 18-162
N*H* 1-14, 18-139, 18-144, 18-153, 18-162, 18-173, 18-178, 18-184
N*H*C*H*C*O*H* 8-27, 8-74
N*H*Cl* 14-19, 14-23, 14-26
N*H*Cl*H*O* (NH_4Cl in water) 9-45, 9-48
N*H*H*C*O* 8-17
N*H*Pt*C*O* 8-48

N* (listed as a secondary element) see also "nitrogen"
Ag*N*O* 8-92, 8-105, 11-52, 11-55, 11-58, 15-63, 15-66, 15-69
B*N* 17-217
C*Br*N* 12-60
C*H*C*S*N*H* 8-17
Ca*N*O*N*H*H*P*O* 8-34
Fe*N* 4-29
Fe*P*N* 4-35
H*B*O*Na*N*O*H* 1-6
K*Pt*C*N*H*O* 8-55, 8-58
Li*N*O* 8-92
Na*N*O* 11-52, 11-55, 11-58, 12-139, 12-144, 12-149, 12-153, 12-157
Na*N*O*Ag*N*O* (see also "salt") 11-52
Ni*N*H*S*O* 15-10, 15-13
Pb*N*O*H*P*O* 8-34
Rb*N*O* 15-66, 15-69
Rb*N*O*Ag*N*O* 15-66
Ti*N* 18-15

Na* (listed as the primary element) see also "sodium"
Na* 1-29, 10-72
Na* (radioactive) 11-21, 11-37
Na*B*Na*O* 12-167
Na*C* 4-44, 18-189, 18-199
Na*Cl* 1-29, 1-78, 2-58, 7-17, 7-21, 9-27, 9-31, 15-78, 16-31
Na*F* 9-27
Na*H*C*O* 1-78
Na*H*P*O* 1-29, 1-78
Na*I* 8-105
Na*N*O* 11-55, 11-58, 12-139, 12-144, 12-149, 12-153, 12-157
Na*N*O*Ag*N*O* (salt melt; see also "salt") 11-52
Na*O*B*O* 6-35, 6-39
Na*O*B*O*Si*O* 11-40
Na*O*B*O*Si*O*Pt* 11-40

Na*O*H* 1-140
Na*O*Rb*O*Si*O* 11-21, 11-33, 11-37, 11-44
Na*O*Rb*Si*O* 11-48, 11-50
Na*O*Si*O* 6-35, 11-13, 11-17, 11-21, 11-24, 11-33, 11-37
Na*O*Si*O*Rb*O*Si*O* 11-13
Na* particles 17-59, 17-63, 17-66, 17-69, 17-72
Na*S*O* 15-22, 15-24
Na*Si*O* 11-17, 11-21, 11-24
Na_2SO_4 water electrolyte solution (see also "electrolyte" and "Na*S*O*") 15-22, 15-24

Na (listed as a secondary element) see also "sodium"
Ag*Na* 17-59, 17-63, 17-66, 17-69, 17-72
H*B*O*Na*N*O*H* 1-6
Si*O*Na*O*Al*O* (glass) 11-52

Naphthalene 5-57

Nb* (niobium) listed as the primary element)
no listings

Nb* (niobium) listed as a secondary element)
Al*Nb* 5-118, 5-130, 5-132, 14-69

n-dodecane (see also "hexadecane") 12-118, 12-121

neoprene-coated nylon fabric 3-3

neuraminidase 16-25, 16-53, 16-58
neuramindase from influenza virus (monoclonal antibody complexes) 16-25

N-heptane (see also "heptane") 18-169

N-Heptanol (see also "heptane") 12-194, 12-198, 12-201, 12-206

n-hexanol (see also "cyclohexane/cyclohexanol") 12-201

Ni* (listed as the primary element) see also "nickel"
Ni* 6-3, 15-10, 15-13, 15-16, 15-19, 15-53, 15-81, 17-199, 18-3, 18-8, 18-12, 18-77, 18-82
Ni*Ag* 6-3, 18-3
Ni*Al*Mo* 18-99, 18-111
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Cu* 6-3
Ni*Cu*Al* 11-89
Ni*Cu*Au* 11-89
Ni*Fe*W*Co* 13-6
Ni*Mo*Ti*C* 5-99, 5-104, 5-106
Ni*N*H*S*O* 15-10, 15-13
Ni*S*O* 15-10, 15-13, 15-16, 15-19
Ni*Sn* 6-3, 6-57
Ni-sulfamate electrolyte 15-10, 15-13
Ni-sulfate electrolyte (see also "electrolyte" and "Ni*S*O*") 15-16, 15-19
Ni*Y*O* 18-82

Ni* (listed as a secondary element) see also "nickel"
Ag*Ni* 8-7
Ag*W*Ni*Cu* 5-95
Al*Ni* 4-47, 4-69, 4-85, 4-89
C*H*O*Ni* 5-62, 5-66
Cu*Ti*Ni* 14-73
Cu*Ti*Ni*Ti* 14-73
Cu*Ti*Ni*Zr* 14-73
Fe*Ni*P*B* 6-21
In*Sb*Ni*Sb* 14-128, 14-131, 14-134

nickel (for the majority of the listings see "Ni*")
nickel anode 15-10, 15-13, 15-16, 15-19
nickel based alloy IN-100 18-77, 18-82
nickel based alloy IN-738 containing approximately 0.1 micron Y_2O_3 dispersed particles (see "Ni*," "Ni*Y*O*," and "particles") 18-82
nickel chloride 17-199
nickel formiate 15-53
nickel molybdenum alloy with titanium carbide particles (see also "Ni*Mo*Ti*C*" and "particles") 5-99, 5-106
nickel molybdenum alloy with titanium carbide whiskers (see also "Ni*Mo*Ti*C*") 5-99
nickel particles (see also "particles") 5-62, 5-66
nickel tubing 18-8, 18-12

Nicotiana tabacum 1-125

nicotinic acid (see also "acid") 1-78

niobium see "Nb*"

nitrogen (for the majority of the listings see "N*")
nitrogen-saturated carbon tetrabromide (see also "C*Br*N") 12-60
nitrogen-supersaturated high speed steel 4-29

N, N-bis(2-phenethyl)perylene-3 10-57

N, N-bis(3,5-xylyl)perylene-3 10-57

nonlinear optical materials see "Nonlinear Optical Materials" in the Key Words Index

nylon fabric 3-3

O

O* (listed as the primary element) see also "oxygen"
no listings

O* (listed as a secondary element) see also "oxygen"
Ag*Al*O* 5-90, 5-95
Ag*Cu*Al*O* 4-47
Ag*N*O* 8-92, 8-105, 11-52, 11-55, 11-58, 15-63, 15-66, 15-69
Al*Al*O* 5-118, 5-130, 5-132
Al*Cu*Al*O* 5-69, 5-72
Al*O* (see also "alumina") 4-29, 4-47, 5-22, 5-69, 5-72, 5-90, 5-95, 5-118, 5-130, 5-132, 6-35, 6-39, 15-10, 15-13, 15-16, 15-19, 18-15, 18-220, 18-224
Al*Si*O* 10-46
Be*O* 6-17
C*H*O* 5-62, 5-66, 9-41, 12-162
C*H*O*Ni* 5-62, 5-66
Ca*C*H*O* 8-12, 8-48
Ca*C*O* 8-12, 8-17, 8-48
Ca*N*O*N*H*H*P*O* 8-34
Cu*Al*O* 5-22, 5-29, 5-76, 5-79, 5-82, 5-85, 5-121, 5-126, 18-105
Cu*O*C* 4-24
Cu*Si*O* 5-18, 5-26
Cu*Sn*Cu*O*C* 4-38
Fe*C*Al*Si*O* 4-32
Fe*C*Si*O* 4-32, 4-35
Ga*O*Ca*O* 6-35, 6-39
Ga*O*Ca*O*Si*O* 6-28, 6-32, 6-35, 6-39
H*B*O* 8-92

H*B*O*Na*N*O*H* 1-6
H*O* (see also "water") 8-81
H*S*O* 8-27, 8-48, 8-74
K*H*P*O* 1-29, 1-78, 1-113, 8-30
K*Pt*C*N*H*O* 8-55, 8-58
Li*N*O* 8-92
Li*O*Si*O* 11-40
Li*O*Si*O*Pt* 11-40
Mg*Th*Mg*O* 5-52
Mg*Th*O* 5-48
N*H*C*H*C*O*H* 8-27, 8-74
N*H*Cl*H*O* 9-45, 9-48
N*H*H*C*O* 8-17
N*H*Pt*C*O* 8-48
Na*B*Na*O* 12-167
Na*H*C*O* 1-78
Na*H*P*O* 1-29, 1-78
Na*N*O* 11-52, 11-55, 11-58, 12-139, 12-144, 12-149, 12-153, 12-157
Na*N*O*Ag*N*O* 11-52
Na*O*B*O* 6-35, 6-39
Na*O*B*O*Si*O* 11-40
Na*O*B*O*Si*O*Pt* 11-40
Na*O*H* 1-140
Na*O*Rb*O*Si*O* 11-21, 11-33, 11-37, 11-44
Na*O*Rb*Si*O* 11-48, 11-50
Na*O*Si*O* 6-35, 11-13, 11-17, 11-21, 11-24, 11-33, 11-37
Na*O*Si*O*Rb*O*Si*O* 11-13
Na*S*O* 15-22, 15-24
Na*Si*O* 11-17, 11-21, 11-24
Ni*N*H*S*O* 15-10, 15-13
Ni*S*O* 15-10, 15-13, 15-16, 15-19
Ni*Y*O* 18-82
Pb*Ag*Ba*O* 14-15
Pb*C*H*O* 8-95
Pb*N*O*H*P*O* 8-34
Pb*O*B* 5-116
Pb*O*Si*O* 6-39
Pb*Si*O*Zn* 5-57
Rb*N*O* 15-66, 15-69
Rb*N*O*Ag*N*O* 15-66
Rb*O*Si*O* 11-13, 11-24, 11-33
Rb*Si*O* 11-24
Si*O* (see also "silica") 5-18, 6-35, 6-39, 9-121, 11-24, 11-28, 15-76, 15-78
Si*O*Na*O*Al*O* (glass) 11-52
Th*O* 5-48
Y*O* 18-82
Zr*O* 18-15

oil (see also "silicone oil") 2-3, 2-13, 2-28, 2-37, 2-41, 12-13, 12-18, 12-53, 12-131, 12-178, 12-184, 12-189, 12-226, 12-229, 12-237, 12-240, 12-243, 12-260, 12-289, 12-294, 15-60, 17-14, 17-155, 17-178, 17-199, 17-205, 18-215
oil (crude) 17-155
oil (dimethyl silicone) see "silicone oil"
oil (Krytox) 2-3, 12-13, 12-18, 12-184, 17-14, 17-199
oil (mixed with blue dye; see also "dye") 12-53
oil paints (see also "paint") 18-241
oil (paraffin) 12-311, 12-316, 17-205
oil (paraffinic) 18-215
oil (silicone) see "silicone oil"

oligometric diisocyanate 4-57

organic compound containing mercury 16-15

organic matrix (see also "Ordered Organics" and the "Organic..." titles in the Key Words Index) 5-62, 5-66

oxygen (for the majority of the listings see "O*")
oxygen-saturated K*Cl* 15-26

P

P* (listed as a primary element) (see also "phosph.../phosphorous") 14-97

P* (listed as a secondary element) see also "phosph.../phosphorous"
Ca*N*O*N*H*H*P*O* 8-34
Fe*C*Si*P*S* 14-101
Fe*Ni*P*B* 6-21
Fe*P*N* 4-35
In*P*S* 8-45
K*H*P*O* 1-29, 1-78, 1-113, 8-30
Na*H*P*O* 1-29, 1-78
Pb*N*O*H*P*O* 8-34
Si*P*B* 9-121

paint 1-14, 18-241
paint (oil) 18-241

palladium see "Pd*"

pancreatic
bovine pancreatic procarboxypeptidase 16-53
pancreatic cells 1-83
porcine pancreatic phospholipase A2 16-58

paper (see also "Paper Formation" in the Key Words Index)
paper 1-14
paper (cellulose) 3-3
paper (chromatography wick material) 18-156, 18-159

paraffin/paraffinic
paraffin 5-10, 17-3
paraffinic oil (see also "oil") 18-215
paraffin oil (see also "oil") 12-311, 12-316, 17-205
paraffin tetracosane (see also "C*H*O*") 12-162
paraffin wax 12-187, 12-190, 18-220, 18-224

particles (see also "beads," "spheres," and "tracer..." (this index) and the "Particle..." titles in the Key Words Index) 1-6, 1-53, 2-28, 4-47, 5-3, 5-14, 5-18, 5-22, 5-33, 5-35, 5-48, 5-57, 5-62, 5-66, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-87, 5-99, 5-104, 5-106, 5-126, 5-140, 6-35, 6-39, 12-18, 12-30, 12-194, 12-198, 12-201, 12-237, 12-240, 12-243, 12-280, 12-307, 13-6, 13-11, 13-18, 15-10, 15-13, 15-16, 15-19, 15-78, 17-59, 18-82, 18-105, 18-108
particles (Ag) 17-59
particles (Al_2O_3) 4-47, 18-105
particles (alumina) 5-22, 5-69, 5-72, 5-76, 5-79, 5-82, 5-85, 5-126, 15-10, 15-13, 15-16, 15-19
particles (carbide) see also "spheres" 5-14, 5-22, 5-106
particles (glass) 17-59, 17-63, 17-66, 17-69, 17-72
particles (latex) see also "latex" 12-194, 12-198, 12-201
particles (magnesium) 12-18
particles (molybdenum) 5-76, 5-79, 5-87, 5-140, 18-108
particles (Na-glass) 17-59, 17-63, 17-66, 17-69, 17-72
particles (nickel) 5-62, 5-66
particles (polystyrene latex) see also "latex" (this index) and "Polystyrene Latex Microspheres" in the Key Words Index 1-53
particles (quartz) 15-78
particles (SiC) 5-33, 5-35

particles (silicon carbide) 5-14, 5-22
particles (SiO_2) 5-18, 6-35, 6-39
particles (Th*O*) 5-48
particles (TiC) 5-104
particles (titanium carbide) 5-99, 5-106
particles (tracer) see "tracer..."
particles (tungsten) see also "spheres" 5-18, 5-22, 13-6, 13-18
particles (Y_2O_3) 5-62, 5-66
particles (zinc) 5-57, 12-280

Pb* (listed as the primary element) see also "lead"
Pb* 4-44, 14-116
Pb*Ag*Ba*O* 14-15
Pb*Au* 12-56
Pb*Bi* 4-55
Pb*C*H*O* 8-95
Pb*Cl* 8-17
Pb*Cu* 17-80
Pb*N*O*H*P*O* 8-34
Pb*O*B* 5-116
Pb*O*Si*O* 6-39
Pb*Pb*Au* 12-56
Pb*S* 8-12, 8-17
Pb*Sb* 14-38, 14-42, 14-150, 14-153
Pb*Si*O*Zn* 5-57
Pb*Sn* 14-109, 18-28
Pb*Sn*In* 17-6, 17-11
Pb*Sn*Te* 8-22, 8-24, 8-84, 9-129
Pb*Te* 9-95
Pb*Tl* 9-125
Pb*Zn* 11-79, 14-145, 14-148, 17-18, 17-142, 17-149
Pb*Zn*Sb* 17-6, 17-11

Pb* (listed as a secondary element) see also "lead"
Al*Pb* 17-75, 17-169, 17-172, 17-187
Al*Pb*Bi* 17-214
Al*Pb*Si*Cu*Sn* 17-56
Cu*Pb* 17-95
In*Pb* 12-71, 12-74
Sn*Pb* 14-29, 14-112
Zn*Bi*Pb* 17-183, 17-187
Zn*Pb* 11-79, 17-18, 17-86, 17-116, 17-149, 17-183, 17-187, 17-191
Zn*Pb*Bi* 17-187

Pd* (palladium) listed as the primary element)
Pd*Cu*Si* 6-48, 6-52, 6-54, 18-71, 18-73
Pd*Si*Cu* 6-48, 6-52, 18-67

Pd* (palladium) listed as a secondary element
no listings

pearlite 14-101

PEG (see "polyethylene glycol")

penicillin 1-78

peptide
muco<u>peptide</u> N-acetyl-muramoylhydrolase (see also "acetate...") 16-12
peptide (synthetic, alpha helicin) 16-48

perfluorinated hydrocarbon 12-213

perfluoroalkyl polyether 12-18, 18-215

Perfluorotributylamine 12-7

phenolphthalein indicator 2-6

phenytoin 8-99

phosph.../phosphorous (for additional listings see "P*")
phosphate buffer (see also "buffer") 1-78, 1-95, 1-121, 1-157, 8-99, 16-5, 16-8, 16-10
phosphate-buffered saline (CMF-PBS) (see also "buffer" and "salt") 1-78, 1-121
phosphate (hydrogen ammonium) 8-34
phosphate (potassium dihydrogen (K*H*P*O*)) 8-30
phosphide (indium) 8-45
phospholipase A-2 16-58
phosphoric acid 1-29, 8-34
phosphorous doped silicon 9-76, 9-91, 9-121
phosphorous doped silicon with two point deposits of boron (see also "Si*P*B*") 9-121
phosphorylase 16-25, 16-31, 16-37, 16-42, 16-48, 16-53

photo...
photocell 18-135
photosystem 1 complex (cyanobacterium) 16-58

phthal...
Naphthalene 5-57
phenolphthalein indicator 2-6
phthalate (d-octyl) 12-222
phthalate (di-n-octyl) 12-175
phthalocyanine (copper) 10-57, 10-62
phthalocyanine (metal free thin films) 10-57, 10-62

pituitary rat cells (see also "cells") 1-69

plasma phosphate-buffered saline (PBS) glucose (see also "buffer," "glucose," and "salt") 1-121

plasmid pSV2-neo 1-113

plaster 1-14

plastic see "Superplastics" in the Key Words Index

plastic beads (see also "beads") 12-22

plated cathode (see also "Cathode" and "Plating" in the in the Key Words Index) 15-22, 15-24

platelet concentrate (see also "cells") 1-121

plates (see also "Liquid Bridge" and "Floating Zone" in the Key Words Index to determine plate materials used in the forming of liquid bridges, liquid columns and floating zones)
plates (boron-nitride) 17-217
plates (ceramic vitreous silica) 17-217
plates (graphite) 17-217

platinum (for the majority of the listings see "Pt*")
platinum complex 8-48
platinum film 10-46

poly... (see also "New Polymorphs," "Polystyrene Latex Microspheres," and the "Poly..." and "Polymer..." titles (all in the Key Words Index)
polyethylene glycol (PEG) 1-95, 1-157, 1-161, 16-31
polyglucosamin acetate 1-140
polymer (anionic) 18-252
polymer (carboxy-terminated copolymers) 17-230
polymer (cationic) 18-252
polymorphs (new) see "New Polymorphs" in the Key Words Index

polyol 4-57
polyphenyl ethers 18-215
polysaccharide 1-48
polystyrene latex particles (see also "latex" and "particles" (this index) and "Polystyrene Latex Microspheres" in the Key Words Index) 1-53
polysulfone (see also "disulfone magenta") 1-170
polyurethane 3-3
polyurethane foam (see also "foam") 4-57

porcine
porcine elastase 16-48, 16-53, 16-58
porcine pancreatic phospholipase A2 16-58

porous material see "Porous Material" in the Key Words Index

potassium (for the majority of the listings see "K*")
potassium acetate 1-118
potassium acetate (triethanolamine-potassium acetate) 1-73
potassium chloride solution (see also "K*Cl*") 15-26
potassium-dihydrogen-phosphate (see also "K*H*P*O*" and "phosph...") 8-30
potassium hydroxide 15-53
potassium iodide (see also "K*I*") 8-95, 11-74
potassium persulfate 18-189, 18-199
potassium-tetracyanoplatinate hydrate (see also "K*Pt*C*N*H*O*") 8-55, 8-58

powder (see also the "Powder..." titles in the Key Words Index) 5-3, 5-26, 12-18, 12-22, 12-135, 12-187, 12-190, 13-3, 13-18, 18-105, 18-108, 18-220, 18-224
powder (aluminum) 12-18, 12-187, 12-190
powder (ceramic) 18-220, 18-224
powder (copper) 18-105, 18-108
powder (indium bismuth eutectic) 5-3
powder (metallic) see also others in this section, i.e., "powder (aluminum)" and "powder (copper)" 18-220, 18-224
powder metallurgy see "Powder Metallurgy" in the Key Words Index
powder (talcum) 12-22
powder (titanium) 12-135
powder (tungsten) 13-3, 13-18

precipitating agent solutions (see also "Solutions" and the "Precipitation..." titles in the Key Words Index) 16-22

printed circuit board (see also "integrated circuit") 18-31, 18-43

proprietary materials 8-63, 8-67

proprietary tissue/cell culture media (see also "cells" and "media/medium") 1-43, 1-48, 1-53

protein (see also the "Protein..." titles in the Key Words Index) 1-17, 1-22, 1-26, 1-57, 1-61, 1-65, 16-3, 16-5, 16-8, 16-10, 16-12, 16-15, 16-18, 16-22, 16-25, 16-31, 16-

37, 16-42, 16-48, 16-53, 16-58, 16-63
protein (colored) see also "dye" 1-17, 1-22, 1-26
protein dye 1-61, 1-65
protein (green fluorescent) 16-25, 16-53
protein (human C-reactive) 16-25, 16-31, 16-37, 16-42, 16-48
protein solution 16-63

protoplasm (see also "cells") 1-14

protoplasts (see also "cells" (this index) and "Protoplasts" in the Key Words Index) 1-105, 1-108, 1-111, 1-113, 1-118, 1-125
protoplasts (evacuolated) 1-125
protoplasts (vacuolated mesophyll) 1-125
protoplasts (yeast) 1-105, 1-108, 1-111, 1-113, 1-118

Pt* (listed as a primary element) see also "platinum" 10-46, 11-40, 15-22, 15-24

Pt* (listed as a secondary element) see also "platinum"
K*Pt*C*N*H*O* 8-55, 8-58
Li*O*Si*O*Pt* 11-40
N*H*Pt*C*O* 8-48
Na*O*B*O*Si*O*Pt* 11-40

pulp (wood) 18-252

purine/purine nucleoside/purine nucleoside phosphorylase
6-idopurine complex 16-37
purine nucleoside 16-48
purine nucleoside phosphorylase 16-25, 16-31, 16-37, 16-42, 16-48, 16-53

Q

QA-700 accelerometers (see also "accelerometers") 18-231

quartz (see also "Si*O*")
quartz 15-76
quartz particles (see also "particles") 15-78

R

rabbit
rabbit erythrocytes (see also "cells") 1-10, 1-29, 1-35, 1-41
rabbit hair 10-33
rabbit red blood cells 1-10, 1-29

radiative/radioactive...
radiative tracer isotope 18-3
radioactive Ag 18-3
radioactive Na 11-21, 11-37
radioactive tracer 11-9, 11-21, 11-37
radioactive Zn-65 tracer 11-9

rare earth alloys (see also "Alloys" and "Rare Earth Alloys" in the Key Words Index) 17-210

rat
rat albumin (see also "albumin") 1-43, 1-48
rat bone marrow cells (see also "cells") 1-35
rat erythrocytes (see also "cells" 1-41
rat lymph node cells (see also "cells") 1-35
rat pituitary cells 1-69
rat spleen cells 1-35

Rb* (listed as a primary element) see also "rubidium"
Rb*N*O* 15-66, 15-69
Rb*N*O*Ag*N*O* 15-66
Rb*O*Si*O* 11-13, 11-24, 11-33
Rb*Si*O* 11-24

Rb* (listed as a secondary element) see also "rubidium"
Na*O*Rb*O*Si*O* 11-21, 11-33, 11-37, 11-44
Na*O*Rb*Si*O* 11-48, 11-50
Na*O*Si*O*Rb*O*Si*O* 11-13

reactant/reacting solutions (for the majority of the listings, see "Reactant Solutions" and the "Reaction..." titles in the Key Words Index)
reactant solutions 8-12
reacting solutions (unspecified) 12-280

reactive
human C-reactive protein CRP (see also "protein") 16-25, 16-31, 16-37, 16-42, 16-48

red blood cells see "cells" and "erythrocytes" (this index) and "Biological Cells" in the Key Words Index

renin 16-48, 16-53

repressor/operator
repressor (LAC) 16-53
repressor/operator complex (TRP) 16-58
repressor/operator (LAC) 16-58

resin
resin core solder (see also "solder") 18-22, 18-25, 18-58
resin (epoxy) 5-109, 17-230

reverse transcripts 16-48, 16-58

ribosome 16-53, 16-58

Ringer's amphibian buffer (RAB) (see also "buffer") 1-128

Rochelle salt (see also "salt") 8-3

RPMI1640 (cell culture medium) see also "medium" 1-86, 1-90

rubber 1-14

rubidium (for the majority of the listings see "Rb*")
rubidium nitrate (see also "Rb*N*O*") 15-66, 15-69

S

6-idopurine complex (see also "purine...") 16-37

S* (listed as the primary element) see also "sulf...," "sulfur," and "sulfate"
S* 14-97
S*F* 7-3, 7-5, 7-8, 7-11, 7-33, 7-36

S* (listed as a secondary element) see also "sulf...," "sulfur" and "sulfate"
C*H*C*S*N*H* 8-17
Cu*S* 15-3, 18-212
Fe*C*Si*P*S* 14-101
Fe*C*Si*S* 18-116
Ge*S* 10-16
Ge*S*Se* 10-16
H*S*O* 8-27, 8-48, 8-74
In*P*S* 8-45
K*Al*S* 8-81
Na*S*O* 15-22, 15-24

Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*N*H*S*O* 15-10, 15-13
Ni*S*O* 15-10, 15-13, 15-16, 15-19
Pb*S* 8-12, 8-17

saccharomyces cerevisiae varieties 1-113

"Saffil" alumina fiber system (see also "alumina" and "fiber") 5-135

saline (see also "salt")
saline (phosphate-buffered) 1-78, 1-121
saline water (see also "water" and "salt") 17-199

salmon sperm deoxyribonucleic acid (DNA) (see also "DNA") 1-3

salt (see also "Na*," "Na*Cl*," and "saline" (this index) and "Molten Salts" and the "Salt..." titles in the Key Words Index)
salt 8-3, 9-27, 9-31, 11-52, 11-74, 15-66
salt (eutectic) see also "Eutectics" in the Key Words Index 9-27, 9-31
salt melt 11-52
salt (Rochelle) 8-3
salt solution (see also "Solutions" in the Key Words Index) 1-128, 7-17, 7-21, 8-3, 8-30, 16-5, 16-8, 16-10, 16-12, 16-15, 16-31, 16-63

samarium see "Sm"

satellite tobacco mosaic virus (see also "virus") 16-58

saturated/saturated solution see also "solution" (this index) and "Saturated Solution" and "Solutions" in the Key Words Index
carbon tetrabromide saturated with argon, hydrogen, or nitrogen) 12-60
high speed steel supersaturated with nitrogen (see also "steel") 4-29
oxygen-saturated KCl 15-26
saturated solution of triglycine sulfate (TGS) (see also "triglycine sulfate," "N*H*C*H*C*O*H*," and "H*S*O*") 8-27

Sb* (listed as the primary element) see also "antimonide/antimony"
no listings

Sb* (listed as a secondary element) see also "antimonide/antimony"
Ag*Sb* 6-25, 18-64
Al*Sb* 17-18
Ga*Sb* 8-38
Ga*Sb*Te* 8-38, 8-42
Ge*Sb* 9-34
In*Ga*Sb* 9-19, 9-25
In*Sb* 6-8, 6-13, 9-5, 9-9, 9-134, 14-145, 14-148
In*Sb*Ni*Sb* 14-128, 14-131, 14-134
In*Sb*Se* 6-13
In*Sb*Sn* 9-5, 9-9, 9-134
In*Sb*Te* 9-3, 9-5, 9-9
Pb*Sb* 14-38, 14-42, 14-150, 14-153
Pb*Sn*Sb* 17-6, 17-11
Te*Ga*Sb* 8-38

scorpion toxin (see also "toxin") 16-25

screen
screen (fuel cell) 2-62
screen (stainless steel) 5-7

Se* (listed as the primary element) see also "selenium"
no listings

Se* (listed as a secondary element) see also "selenium"
Ge*S*Se* 10-16
Ge*Se* 10-7, 10-12, 10-20, 10-24
Ge*Se*Te* 10-16
In*Sb*Se* 6-13

sea anemone toxin (see also "toxin") 16-25

seed crystals see "Seed Crystals" in the Key Words Index

selenium (for the majority of the listings see "Se*")
selenium-doped indium antimonide (see also "In*Sb*Se*") 6-13

semipermeable membranes see "Semipermeable Membranes" in the Key Words Index

serine (an amino acid) see also "protein" 1-29

serum (see also "albumin" and "human")
serum albumin 1-65, 1-113, 1-118, 16-42, 16-48, 16-58
bovine serum albumin 1-118
fetal bovine serum 1-78
human serum 1-86, 1-90
human serum albumin 1-65, 16-42, 16-48, 16-58
human serum transferrin 16-25

sheet nylon 3-3

shells (soda-lime-silica glass) see also "beads" 6-39

Si* (listed as the primary element) see also "silicon"
Si* 9-84, 9-88
Si*As*Te* 9-57, 9-61, 9-63, 9-65, 9-67
Si*B* 9-117
Si*C* 5-7, 5-33, 5-35
Si*C* particles (see also "particles") 5-33, 5-35
Si*C* whiskers 5-7, 5-41, 5-45
Si*O* (see also "silica") 5-18, 6-35, 6-39, 9-121, 11-24, 11-28, 15-76, 15-78
Si*O* particles (see also "particles") 5-18, 6-35, 6-39
Si*O*Na*O*Al*O* (glass) 11-52
Si*P* 9-76, 9-91, 9-121
Si*P*B* 9-121

Si* (listed as a secondary element) see also "silicon"
Ag*Si*C* 5-41, 5-45
Al*Pb*Si*Cu*Sn* 17-56
Al*Si* 11-86, 14-52, 14-80, 14-124, 14-126
Al*Si*B* 17-222, 17-224
Al*Si*C* 5-22, 5-33, 5-35
Al*Si*O* 10-46
Au*Si* 14-124, 14-126
Ca*O*Ga*O*Si*O* 6-28, 6-32
Cu*Si*C* 5-14, 5-22, 5-29
Cu*Si*O* 5-18, 5-26
Cu*Ti*Si* 14-73
Cu*Ti*Si*Ti* 14-73
Cu*Ti*Si*Zr* 14-73
Fe*C*Al*Si*O* 4-32
Fe*C*Si*O* 4-32, 4-35
Fe*C*Si*P*S* 14-101
Fe*C*Si*S* 18-116
Ga*O*Ca*O*Si*O* 6-28, 6-32, 6-35, 6-39
In*Bi*Si*C*Ar* 5-7
Li*O*Si*O* 11-40
Li*O*Si*O*Pt* 11-40
Na*O*B*O*Si*O* 11-40
Na*O*B*O*Si*O*Pt* 11-40

Na*O*Rb*O*Si*O* 11-21, 11-33, 11-37, 11-44
Na*O*Rb*Si*O* 11-48, 11-50
Na*O*Si*O* 6-35, 11-13, 11-17, 11-21, 11-24, 11-33, 11-37
Na*O*Si*O*Rb*O*Si*O* 11-13
Na*Si*O* 11-17, 11-21, 11-24
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Pb*O*Si*O* 6-39
Pb*Si*O*Zn* 5-57
Pd*Cu*Si* 6-48, 6-52, 6-54, 18-71, 18-73
Pd*Si*Cu* 6-48, 6-52, 18-67
Rb*O*Si*O* 11-13, 11-24, 11-33
Rb*Si*O* 11-24

silica (see also "Si*O*")
silica 15-76, 17-217
silica coating (see also "Si*O*") 9-121
silica modified gallia-calcia glass (see also "Ga*O*Ca*O*Si*O*" and "glass") 6-28, 6-32, 6-35, 6-39
silica (soda lime) 5-57, 11-28
silica (vitreous) 11-17, 17-217

silicate
silicate (alkali) 5-57, 11-44
silicate glass (see also "glass") 6-57
silicate (sodium disilicate) 11-17
silicate (sodium trisilicate) 11-17, 11-21, 11-24

silicon (for the majority of the listings see "Si*"; for additional listings see "silica," and "silicate")
silicon carbide 5-14, 5-22, 5-29
silicon carbide particles (see also "particles") 5-14, 5-22
silicon doped with boron (see also "Si*B*") 9-117
silicon doped with phosphorous (see also "Si*P*") 9-76, 9-91, 9-121
silicon monoxide coated filament 10-46
silicon rod, n-type doped (see also "Si*") 9-84, 9-88

silicone oil (see also "oil") 2-13, 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 12-77, 12-131, 12-178, 12-217, 12-222, 12-226, 12-229, 12-233, 12-237, 12-240, 12-243, 12-260, 12-289, 12-294
silicone oil (AK silicone oil) 12-131, 12-289
silicone oil (dimethyl silicone) 2-33, 2-52, 2-54

silver (for the majority of the listings see "Ag*")
silver coating 13-3
silver fibers (see also "fiber") 4-3
silver film 10-46
silver iodide (see also "Ag*I*") 10-28, 10-33, 11-74
silver nitrate (see also "Ag*N*O*") 11-55, 11-58, 15-63, 15-66, 15-69
silver nitrate solution 8-7
silver/silver chloride (see also "Ag*Ag*Cl*") 15-26
silver/sodium glass (see also "Ag*Na*" and "glass") 17-66, 17-69, 17-72

single crystals see "Single Crystals" in the Key Words Index

6-idopurine complex (see also "purine") 16-37

slurry solutions (see also "Slurry Solutions" in the Key Words Index)
slurry/fiber mixture 18-252

Sm* (samarium) listed as the primary element
no listings

Sm* (samarium) listed as a secondary element
Co*Sm* 14-163

Sn* (listed as the primary element) see also "tin"
Sn* 11-65, 11-82, 14-78
Sn* (isotopes) 11-65
Sn*Ag* 11-82, 14-61, 18-19
Sn*Al* 14-59
Sn*Bi* 11-82, 14-32
Sn*Co* 11-62
Sn*In* 11-70
Sn*Pb* 14-29, 14-112
Sn*Zn* 14-49

Sn* (listed as secondary element) see also "tin"
Al*Pb*Si*Cu*Sn* 17-56
Bi*Sn* 11-82, 14-105
Cu*Sn*Cu*O*C* 4-38
In*Sb*Sn* 9-5, 9-9, 9-134
Ni*Sn* 6-3, 6-57
Pb*Sn* 14-109, 18-28
Pb*Sn*In* 17-6, 17-11
Pb*Sn*Te* 8-22, 8-24, 8-84, 9-129

snow see "Snow Crystals" in the Key Words Index

soap (see also "detergent")
soap 2-13, 12-27, 12-40
soap additives 12-30
soap foam (see also "foam") 12-30
soap (Miranol Jem concentrate) 12-34
soap solution 12-30

soda-lime-silica/silicate
soda-lime-silica glass (see also "glass") 5-57, 6-39, 11-28
soda-lime-silicate glass beads (see also "beads" and "glass") 5-57
soda-lime silica glass shells 6-39
soda-lime-silica glass with helium bubble 11-28

sodium (for the majority of the listings see "Na*")
mono<u>sodium</u> aspartate 16-22
sodium acetate 17-3
sodium acetate trihydrate 17-3
sodium bicarbonate (see also "Na*C*") 4-44, 18-189, 18-199
sodium borate glass (see also "glass" and "Na*B*Na*O*") 12-167
sodium chloride (see also "Na*Cl*") 2-58, 7-17, 7-21, 9-27, 9-31, 16-31
sodium chloride solution (see also "Na*Cl*") 7-17, 7-21, 16-31
sodium disilicate 11-17
sodium dodecylsulfate 2-26
sodium fluoride (see also "Na*F*") 9-27
sodium hydroxide 17-199
sodium iodide (see also "Na*I*") 8-105
sodium metasulfite 2-6
sodium nitrate (see also "Na*N*O*") 11-55, 11-58, 12-139, 12-144, 12-149, 12-153, 12-157, 16-22
sodium-silver glass 17-66, 17-69, 17-72
sodium sulfite 2-6
sodium trisilicate (see also "Na*Si*O*") 11-17, 11-21, 11-24

softwood kraft pulp 18-252

solder (see also "Solder..." titles in the Key Words Index)
solder 12-172, 18-19, 18-22, 18-25, 18-28, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52
solder alloy 12-172
solder (coreless) 18-22, 18-25, 18-58
soldered beams 18-28
solder paste 18-25
solder (resin-core) 18-22, 18-25, 18-58
solder (solid-core) 18-31, 18-34, 18-37

solution(s) (see also "Solutions" in the Key Words Index)
solution (acetone-water) see also "acetone" and "water" 12-307, 12-321
solution (acidic) see also "acid" 16-37
solution (alcohol-water (ethanol)) solution (see also "water") 12-311, 12-316
solution (aqueous) see "Aqueous Solution" in the Key Words Index
solution (buffer/buffered) see also "buffer" 1-22, 1-26, 1-35, 16-5, 16-8, 16-10, 16-12, 16-15
solution (copper-sulfate electrolyte solution) 18-212
solution (fibrigen) 1-152
solution (metallic) see "Metallic Solutions" in the Key Words Index
solution (Na_2SO_4 water electrolyte) 15-22, 15-24
solution (potassium chloride saturated with oxygen) 15-26
solution (precipitating agent) 16-22
solution (protein) see also "protein" 16-63
solution (reactant/reacting) 8-12, 12-280
solution (salt) see also "salt" 1-128, 7-17, 7-21, 8-3, 8-30, 16-5, 16-8, 16-10, 16-12, 16-15, 16-31, 16-63
solution (saturated, triglycine sulfate) see also "Saturated Solution" in the Key Words Index 8-27
solution (silver nitrate) 8-7
solution (slurry) see "slurry solutions" (this index) and "Slurry Solutions" in the Key Words Index
solution (soap) see also "soap" 12-30
solution (sodium chloride) see also "Na*Cl*" 7-17, 7-21, 16-31
solution (sucrose) 12-13

solubilized collagen (see also "collagen") 1-135

solvent see "Solvent" in the Key Words Index

Sorbite 1-113

sorbitol 1-118

source material (see also "Source Material" in the Key Words Index) 10-7, 10-12, 10-20, 10-24

SP2...
SP2 cells (see also "cells") 1-113
SP2/0-UZ hybridoma clone (see also "hybridoma") 1-118

SP2 + pSV2-ndeo plasmid (Myeloma Strain) see also "strains" 1-113
SP2 X G8 Hybrid Hybridoma strain (Myeloma strain) 1-113

space vacuum see "Sampling of Space Vacuum," "Space Vacuum" and the "Vacuum..." titles in the Key Words Index

sperm (salmon DNA) 1-3

spheres (see also "beads," "Eccospheres," "particles," and "tracers...," (this index) and "Spheres," "Polystyrene Latex Microspheres," and the "Particle..." titles (in the Key Words Index))
spheres 2-28, 2-33, 5-3, 5-7, 5-57, 5-62, 5-66, 12-22, 12-217, 12-222, 12-243, 12-246, 12-249, 13-3, 14-120, 17-3, 17-199
spheres (ceramic microspheres solid tracers) 2-28
spheres (copper-coated boron carbide) 5-3
spheres (copper-coated tungsten) 5-3, 5-7
spheres (glass echospheres) 12-217, 12-222, 12-243
spheres (microspheres) 2-28, 17-3
spheres (stainless steel) 12-249
spheres (tracer particles (Eccospheres/Echospheres)) 2-33, 12-217, 12-222, 12-243
spheres (tungsten) 5-3, 5-7, 13-3, 17-3

spleen
spleen (horse spleen ferritin) 1-17
spleen (rat cells) 1-35

SRG-10 superrefined paraffinic oil (see also "oil") 18-215

stain
stain (sudan orange) see also "dye" 17-199

stainless steel (see also "steel")
stainless steel 2-13, 5-7, 12-249, 14-3, 17-199, 18-3, 18-215
stainless steel mixing ball 17-199
stainless steel screen (see also "screen") 5-7
stainless steel spheres (see also "spheres") 12-249
stainless steel wicks 2-13

starch (HES-hydroxyethyl) 1-86

steam (see also "water") 1-14

steel (see also and "stainless steel")
steel 2-13, 4-27, 4-29, 5-7, 12-22, 12-178, 12-249, 14-3, 14-120, 17-199, 18-3, 18-215
steel (AISI steel) 14-120
steel (high speed steel supersaturated with nitrogen) 4-29
steel marbles 12-22
steel (surface material) 12-178

strains
strain (Hybridoma) 1-113
strain (mammalian) 1-118
strain (Myeloma Strain Sp2 + pSV2-neo Plasmid) 1-113
strain (Myeloma Strain SP2 X G8 Hybrid Hybridoma Strain) 1-113
strain (yeast) see also "yeast" 1-105, 1-108, 1-111, 1-118

strain (yeast strain AH 22 pADH-040-2 HIS HIS 4- X AH215 Leu 2- HIS3) see also "yeast" 1-105, 1-108, 1-111

strawberry drink (see also "dye") 12-46

streptomycin sulfate (see also "sulfate") 1-78

styrene (see also "Polystyrene Latex Microspheres" in the Key Words Index) 10-38, 18-189, 18-199, 18-203, 18-207

substrates see "Substrates" in the Key Words Index

succinonitrile 11-91, 14-137, 14-141

sucrose
sucrose-based polyol 4-57
sucrose (solution) 12-13

sudan orange (see also "dye") 17-199

sulfate
potassium per<u>sulfate</u> 18-189, 18-199
sodium dodecyl<u>sulfate</u> 2-26
sulfate (ammonium) 16-5, 16-8, 16-10, 16-15, 16-31
sulfate (copper) see also "Cu*S*" 15-3, 18-212
sulfate (Ni-sulfate electrolyte) 15-16, 15-19
sulfate (streptomycin) 1-78
sulfate (triglycine) (TGS) 8-27, 8-74

sulfur (for the majority of the listings see "S*"; see also "sulfate" and "sulf...")
sulfur-doped indium phosphide (see also "In*P*S*") 8-45
sulfur hexafluoride (see also "S*F*") 7-5, 7-8, 7-11, 7-33, 7-36

sulf... other than "sulfate" and "sulfur"
di<u>sulfone</u> magenta 8-67
sodium meta<u>sulfite</u> 2-6
sulfamate electrolyte (Ni-) 15-10, 15-13
sulfide (lead) see also "Pb*S*" 8-12
sulfite (sodium) 2-6
sulfone (poly) 1-170
sulfoxide (dimethyl) 1-10
sulfuric acid 8-48

superfluid helium (see also "He*") 12-271, 12-275

superfluids see "Superfluids" in the Key Words Index

superplastics see "Superplastics" in the Key Words Index

supersaturated (see also "Supersaturation" in the Key Words Index)
high speed steel supersaturated with nitrogen 4-29

surfactants see "Surfactants" in the Key Words Index

suspending buffer (see also "buffer") 1-10

synthetic
synthetic DNA fragment (see also "DNA") 16-25
synthetic peptide (alpha helicin) 16-48

systems exhibiting a miscibility gap see "Systems Exhibiting a Miscibility Gap," "Immiscible Alloys," and "Immiscible Fluids" in the Key Words Index

T

10-bis(dicarboximide) 10-57

12 base Pair DNA (see also "DNA") 16-58

T3H-Thymidine 1-86, 1-90

Ta* (tantalum) listed as the primary element 14-3

Ta* (tantalum) listed as a secondary element
Al*Ta* 14-69

talcum powder (see also "powder") 12-22

tantalum see "Ta*"

TCNQ (tetracyanoquinodimethane) 8-17

Te* (listed as the primary element) see also "tellurium"
Te* 9-3
Te*Ga*Sb* 8-38
Te*Tl* 17-43

Te* (listed as a secondary element) see also "tellurium"
Cd*Hg*Te* 9-144
Cd*Te* (cadmium telluride) 8-52, 8-88, 9-144, 10-65
Cd*Te*Cl* (cadmium telluride doped with chlorine) 8-88
Ga*Sb*Te* 8-38, 8-42
Ge*Se*Te* 10-16
Ge*Te* 10-7, 10-12
In*Sb*Te* 9-3, 9-5, 9-9
Pb*Sn*Te* 8-22, 8-24, 8-84, 9-129
Pb*Te* 9-95
Si*As*Te* 9-57, 9-61, 9-63, 9-65, 9-67

tea (with sugar) 11-3

teflon fabric 3-3

tellurium (for the majority of the listings see "Te*")
tellurium-doped GaSb (see also "Ga*Sb*Te*") 8-38
tellurium-doped indium antimony (In*Sb*Te*) 9-3, 9-5

10-bis(dicarboximide) 10-57

ternary systems see "Ternary Systems" in the Key Words Index

tetra...
tetrahydrofuran 1-170
tetramehoxysilane (TMS) 8-34
tetrathiofulvalene-tetracyanoquinodimethane (TTF-TCNQ) 8-17

TGS (see also "triglycine sulfate") 8-27, 8-74

Th* (thorium) listed as the primary element
Th*O* 5-48
Th*O* particles (see also "particles") 5-48

Th* (thorium) listed as a secondary element
Mg*Th*Mg*O* 5-52
Mg*Th*O* 5-48

thallium (for the majority of the listings see "Tl*")
indium doped with thallium (In*Tl*) 9-112

T-helper lymphocytes (see also "lymphocytes") 16-65

thin films see "films" (this index) and "Films" and "Thin Films" in the Key Words Index

thorium see "Th*"

thrombin 1-152

thymol blue (see also "dye") 2-9

Ti* (listed as the primary element) see also "titanium"
Ti*Al*V* 14-167
Ti*C* 5-99, 5-104, 5-106
TiC particle dispersion strengthened Ni-Mo (see also "Ni*Mo*Ti*C*" and "particle") 5-104
Ti*N* 18-15

Ti* (listed as a secondary element) see also "titanium"
Al*Ti* 14-69, 14-76
Al*Ti*H* 4-41
Cu*Ag*Ti* 18-15
Cu*Ti* 14-73
Cu*Ti*Al*Ti* 14-73
Cu*Ti*Al*V* 14-73
Cu*Ti*B* 14-73
Cu*Ti*Co* 14-73
Cu*Ti*Co*Ti* 14-73
Cu*Ti*Fe* 14-73
Cu*Ti*Fe*Ti* 14-73
Cu*Ti*Fe*Zr* 14-73
Cu*Ti*Ni* 14-73
Cu*Ti*Ni*Ti* 14-73
Cu*Ti*Ni*Zr* 14-73
Cu*Ti*Si* 14-73
Cu*Ti*Si*Ti* 14-73
Cu*Ti*Si*Zr* 14-73
Ni*C*Cu*Fe*Mn*S*Si*Cr*Ti*Co* 18-12
Ni*Mo*Ti*C* 5-99, 5-104, 5-106

tin (for the majority of the listings see "Sn*")
tin-doped indium antimonide (see also "In*Sb*Sn*") 9-134
tin-doped indium antimony (see also "In*Sb*Sn*") 9-5
tin doped with Sn isotopes (see also "Sn*") 11-65

tissue culture media (see also "cell/cells") 1-48, 1-53

titanium (for the majority of the listings see "Ti*")
titanium carbide particles (see also "particles" and "Ti*C*") 5-99, 5-106
titanium-carbide particles in molybdenum-nickel alloy 5-99, 5-106
titanium carbide whiskers (see also "whiskers" and "Ti*C*") 5-99
titanium carbide whiskers in molybdenum-nickel alloy (see also "whiskers" and "Ti*C*") 5-99
titanium-hydride additions in aluminum (see also "Al*Ti*H*") 4-41
titanium metal powder 12-135
titanium nitride 18-15

Tl* (listed as the primary element) see also "thallium"
no listings

Tl* (listed as a secondary element) see also "thallium"
In*Tl* 9-112
Pb*Tl* 9-125
Te*Tl* 17-43

tobacco mosaic virus 16-53, 16-58

toluene/toluol
toluene 12-115, 12-126
toluene solvent (see also "solvent") 8-63
toluol 12-123

toxin
toxin (sea anemone) 16-25
toxin (scorpion) 16-25

tracer... (see also "beads," "Eccospheres," "flakes," "particles," and "spheres" (this index) and "Tracer Particles" in the Key Words Index)
tracer (ceramic) 2-28, 2-58
tracer (ceramic microspheres) 2-28
tracer (iriodine) 12-233
tracer (latex particles) see also "latex" 12-201
tracer material/tracer particles 2-28, 2-33, 2-58, 11-9, 11-21, 12-13, 12-184, 12-187, 12-190, 12-201, 12-217, 12-222, 12-233, 12-237, 12-240, 12-243, 12-284, 12-307, 18-3, 18-12
tracer material (tiny flakes) 12-13
tracer particles (Eccosphere or Echosphere) see also "Eccospheres" and "spheres" 2-33, 12-217, 12-222, 12-243
tracer (radioactive) 11-9, 11-21, 11-37, 18-3
tracer (radioactive isotope) 18-3
tracer (radioactive Zn-65) 11-9

transport agent 10-7, 10-12, 10-16, 10-68

tri...
triclorotrifluroethane 15-36, 15-41
triethanolamine-potassium acetate 1-73
triglycine sulfate (TGS) (see also "N*H*C*H*C*O*H*" and "H*S*O*") 8-27, 8-74
tris-glycine 1-17
trisilicate (sodium) 11-17, 11-21, 11-24

Triton X-100 (a wetting agent) see also "Wetting" in the Key Words Index 2-65, 12-256

TRP repressor/operator complex see "repressor/operator"

trypan blue (dye) (see also "dye") 1-157, 1-161, 2-65, 11-95, 17-199

T-suppressor lymphocytes (see also "lymphocytes") 16-65

TTF (tetrathiofulvalene) see also "TCNQ" 8-17

trypsin 1-78

tubes (see also "Capillary Tubes" in the Key Words Index)
tubes (copper) 18-19

tungsten (for the majority of the listings see "W*")
tungsten (coating) 5-3, 5-7
tungsten-cobalt carbide 5-124
tungsten filament 10-72, 18-129
tungsten filament (coated) with aluminum 10-72
tungsten microspheres (see also "spheres") 17-3
tungsten particles (see also "particles" and "spheres") 5-18, 5-22, 13-6, 13-18
tungsten powder 13-3, 13-18
tungsten spheres (see also "spheres" and "particles") 5-3, 5-7, 13-3, 17-3
tungsten spheres (argon and copper coated) 5-7

tungsten spheres (copper coated) 5-3, 5-7

12 base Pair DNA (see also "DNA") 16-58

two-phase system see "Two-Phase System" in the Key Words Index

Tylose additive 15-26

Type III vitreous silica (see also "silica") 11-17

U

unknown 1-111, 2-19, 5-39, 5-130, 5-132, 9-104, 12-96, 12-103, 12-113, 12-129, 12-181, 12-209, 12-211, 12-305, 13-14, 13-16, 14-55, 14-78, 14-124, 14-126, 16-70, 18-58, 18-71, 18-95, 18-97, 18-121, 18-123, 18-125, 18-127, 18-166, 18-228, 18-250

urea 8-63

urease 16-53

urokinase 16-65

V

V* (vanadium) listed as the primary element
no listings

V* (vanadium) listed as a secondary element
Cu*Ti*Al*V* 14-73
Ti*Al*V* 14-167

vacuolated mesophyll protoplasts (see also "protoplasts") 1-125

vacuum (see also "Vacuum" and "Space Vacuum" in the Key Words Index)
vacuum-distilled perfluoroalkyl polyether 18-215

vanadium see "V*"

virus
virus (influenza) 16-25
virus (tobacco mosaic) 16-53, 16-58

vitreous silica ceramic plates (see also "ceramic," "plates," and "silica") 17-217

W

W* (listed as the primary element) see also "tungsten"
W* 5-3, 5-7, 10-72, 17-3, 18-129, 18-220, 18-224
W*Ag* 5-90, 13-3
W*C*Co* 5-124
W*Cu* 13-3
W*Ni*Fe* 13-18

W* (listed as a secondary element) see also "tungsten"
Ag*W* 5-95
Ag*W*Ni*Cu* 5-95
Co*W*C* 13-11
Cu*W* 5-3, 5-7, 5-18, 5-22, 5-29, 13-21
Ni*Fe*W*Co* 13-6

water (see also "distilled water," "dyed water," and "steam" (this index) and the "Water..." titles in the Key Words Index)
water 1-29, 1-140, 1-144, 1-148, 1-157, 1-161, 1-165, 1-170, 2-3, 2-9, 2-13, 2-16, 2-21, 2-24, 2-46, 2-49, 2-58, 2-65, 7-31, 8-3, 8-17, 8-48, 8-81, 8-95, 9-39,

9-45, 9-48, 11-3, 11-95, 12-3, 12-13, 12-24, 12-27, 12-30, 12-34, 12-38, 12-40, 12-42, 12-46, 12-53, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-105, 12-109, 12-115, 12-118, 12-121, 12-123, 12-126, 12-215, 12-233, 12-246, 12-249, 12-284, 12-289, 12-307, 12-311, 12-316, 12-321, 14-19, 14-23, 14-26, 15-5, 17-14, 17-155, 17-178, 17-199, 18-19, 18-156, 18-159, 18-189, 18-199, 18-203, 18-207, 18-252
water-acetone solution 12-307, 12-321
water and air 12-42
water-alcohol (ethanol) solution 12-311, 12-316
water (desalinated) 2-21, 2-24
water (distilled) see "distilled water"
water drops 12-50
water (dyed) see "dyed water"
water-glycerin mixture 12-98
water-isobutyric acid system 7-31
water (Na_2SO_4 water electrolyte solution) see also "electrolyte" 15-22, 15-24
water (NH_4Cl in water) 9-45, 9-48
water (NH_4HCO_3 in water) 8-17
water (saline) see also "saline" and "salt" 17-199
water vapor 10-28, 10-33
water with additives 12-256
water with wetting agent 2-3

whipped cream 1-14

whiskers (see also "Whiskers" in the Key Words Index)
whiskers (Si*C*) 5-7, 5-41, 5-45
whiskers (titanium-carbide) 5-99

white blood cells (see also "cell," "cells (white blood)," "leukocytes," and "lymphocytes" (this index) and "Biological Cells" in the Key Words Index) 1-86, 1-90, 1-121

white cast iron (see also "Fe*" and "iron") 14-97

wicks (see also "Wicking" in the Key Words Index)
wick (chromatography paper) 18-156, 18-159
wick (cloth) 2-13
wick (stainless steel) 2-13

wire (see also "Hot-Wire Technique" in the Key Words Index)
wire 8-7, 18-34, 18-37
wire (copper) 8-7, 18-34

wisteria lectin (see also "lectin") 16-25

wood
hardwood/softwood kraft pulp 18-252

X

Xe* (xenon)
10-20, 10-24, 10-57, 10-62

Y
Y* (yttrium)
Y*O* 18-82
Y_2O_3 dispersed particles (see also "particles") 18-82

yeast
yeast protoplasts (see also "protoplasts") 1-105, 1-108, 1-111, 1-113, 1-118
yeast strain (see also "strains") 1-105, 1-108, 1-111, 1-118
yeast strain AH 22 pADH-040-2 HIS HIS 4- X AH215 Leu 2- HIS3 (see also "strains") 1-105, 1-108, 1-111
yeast system 1-105, 1-108, 1-111, 1-113, 1-118

yttrium see "Y*"

Z

zinc (for the majority of the listings see "Zn*")
zinc particles (see also "particles") 5-57, 12-280
zinc with pellets of radio-active zinc-65 tracer 11-9

zirconia/zirconium (for the majority of the listings see "Zr*") 18-15

Zn* (listed as the primary element) see also "zinc"
Zn* 11-9, 12-280
Zn*Bi* 17-90, 17-92, 17-102, 17-105, 17-107, 17-110, 17-113, 17-183, 17-187, 17-217
Zn*Bi*Cu* 17-99
Zn*Bi*Mg* 17-99
Zn*Bi*Pb* 17-183, 17-187
Zn*Cl* 18-19
Zn*Pb* 11-79, 17-18, 17-86, 17-116, 17-149, 17-183, 17-187, 17-191
Zn*Pb*Bi* 17-187

Zn* (listed as a secondary element) see also "zinc"
Al*Zn* 4-51
Bi*Zn* 17-82
Cu*Zn* 18-28
Pb*Si*O*Zn* 5-57
Pb*Zn* 11-79, 14-145, 14-148, 17-18, 17-142, 17-149
Pb*Zn*Sb* 17-6, 17-11
Sn*Zn* 14-49

Zr* (listed as the primary element) see also "zirconia/zirconium"
Zr* 18-15
Zr*F*Ba*F*La*F* 6-44
Zr*O* 18-15

Zr* (listed as a secondary element) see also "zirconia/zirconium"
Al*Zr* 5-118, 5-130, 5-132
Cu*Ti*Fe*Zr* 14-73
Cu*Ti*Ni*Zr* 14-73
Cu*Ti*Si*Zr* 14-73

Index F: Container Materials

Container Materials Index

A

acrylic 8-95, 12-256, 12-301
acrylic plastic (see also "plastic") 8-95, 12-256

AISI 321 stainless steel (see also "stainless steel" and "steel" (this index))
14-38, 14-42

Al* (see also "Al*..." titles (below) and "aluminum" and "alumina") 2-28, 2-33, 2-37, 2-41, 2-52, 2-54, 2-58, 5-3, 5-7, 5-10, 5-109, 8-3, 8-30, 8-34, 12-13, 12-71, 12-74, 12-162, 12-172, 12-184, 12-217, 12-222, 12-252, 12-264, 12-271, 12-289, 12-311, 12-316, 14-105, 14-150, 15-57, 16-25, 17-146, 17-152, 17-155, 17-205, 17-230, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-77, 18-139, 18-144, 18-149, 18-153, 18-220, 18-224
Al* (Teflon™-coated) see also "Teflon™" 8-3, 8-30
Ni*Al* 18-77

Al*O* (see also "alumina") 4-29, 4-32, 4-35, 4-38, 4-41, 5-76, 5-79, 5-126, 5-140, 11-74, 13-6, 13-11, 13-18, 14-69, 14-97, 14-100, 14-153, 14-163, 17-34, 17-38, 17-43, 17-51, 17-75, 18-77, 18-82, 18-99, 18-111, 18-116
Al*O* (corundum) 5-76, 5-79

Al*O*Mg*O* (ceramic film) 14-159

alumina (see also "Al*O*") 4-29, 4-32, 4-35, 4-38, 4-41, 5-76, 5-79, 5-126, 5-140, 13-6, 13-11, 13-18, 14-69, 14-100, 14-153, 14-163, 17-34, 17-38, 17-43, 17-51, 17-75, 18-99, 18-111
alumina (impervious) 11-74
alumina (plasma-sprayed) 14-97, 18-77, 18-82
alumina (plasma sprayed, skin material) 18-116
alumina skin 5-76, 5-79

aluminum (see also "Al*")
Aluminum 6061 14-105
aluminum disks 2-28, 2-33, 2-52, 2-54, 2-58, 12-217, 12-222, 17-205
aluminum endcaps 12-252
aluminum endplates 2-41, 12-264
aluminum furnace with Teflon™-coated release paper 5-109
aluminum heat pipes 18-139
aluminum (high wettability) 12-13
aluminum oxide (corundum) (for the majority of the aluminum oxide listings see "Al*O*") 5-76, 5-79
aluminum tube (sealed, hollow) 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52

ammonium tartrate (skin material produced by electrolytic oxidation in ammonium tartrate or natural oxidation) 18-86

anti-spreading/anti-wetting coatings/materials (see also "coated materials" and "coating" (this index))
anti-spreading 3M FC-721™ 12-222
anti-spreading material (applied as an aqueous solution and dried) 2-37
anti-wetting coating 12-284

Au* (see also "gold")
Au*Cu* 12-280

B

boron nitride 5-72, 5-132, 5-135, 9-73, 9-125, 13-3, 14-46, 14-159, 14-163, 17-22, 17-92, 17-105, 17-214, 17-222, 17-224
boron-nitride cone 14-159

borosilicate type glass see "glass" and "Pyrex™"

C

C* (see also "carbon") 4-11, 4-47, 4-51, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-99, 5-104, 5-106, 9-19, 9-27, 9-31, 9-34, 9-51, 9-54, 11-9, 11-40, 11-65, 11-70, 12-56, 12-139, 12-144, 12-149, 12-153, 12-157, 14-8, 14-29, 14-32, 14-35, 14-65, 14-128, 17-18, 17-92, 17-95, 17-99, 17-102, 17-110, 17-116, 17-142, 17-181, 17-183, 17-187, 17-191, 17-196

can (food can), 8-3

carbon (see also "C*", "graphite," "polycarbonate," and "polyfluorocarbon")
carbon coated silica 9-19
carbon (glass-like) 11-40
carbon (graphite) ampoule with carbon piston for applying pressure 5-99, 5-104, 5-106

ceramic film 14-159

cerodur (glass) 15-41

clay crucible 5-121, 5-124

coated materials (see also (1) "film," "plasma-spray," "skin," and "wettability" (this index) and (2) "Coated Surfaces," "Hydrophobic Surfaces," "Liquid Spreading," "Non-wetting of Container," "Plasma Spray Coating," "Wetting," and the "Film..." and "Skin..." titles (in the Key Words Index))
coated material 12-222
coated aluminum 8-3, 8-30
coated copper 12-280
coated furnace release paper 5-109
coated glass 1-29, 9-19, 12-105, 12-109, 12-284 15-41, 17-226
coated graphite 9-27, 9-31
coated Pyrex™ tubes 1-29
coated silica 9-19
coated stainless steel 8-63, 8-67, 15-10, 15-13, 15-16, 15-19

coating see also (1) "film," "plasma-spray," "skin," and "wettability" (this index) and (2) "Coated Surfaces," "Hydrophobic Surfaces," "Liquid Spreading," "Non-wetting of Container," "Plasma Spray Coating," "Wetting," and

the "Film..." and "Skin..." titles (in the Key Words Index))
coating (anti-spreading) 12-222
coating (anti-wetting) 12-284
coating (carbon) 9-19
coating (dextran) 17-226
coating (gold) 15-41, 15-44, 15-49, 12-280
coating (graphite) 5-33, 5-35 17-142
coating (hydrophobic) see also "Hydrophobic Surfaces" in the Key Words Index 12-284
coating (non-stick) see also "Teflon™" 5-10
coating (polyfluorocarbon) 12-284
coating (PTFE Teflon™ (polytetrafluoroethylene)) 15-10, 15-13, 15-16, 15-19
coating (quartz glass) 9-109
coating (silica) 9-117
coating (silicon) 12-105, 12-109
coating (Teflon™) 5-109, 8-3, 8-30, 8-63, 8-67, 12-284, 12-307, 15-10, 15-13, 15-16, 15-19
coating (Ti*N*) 17-142
coating, tin oxide 18-89, 18-92

copper (see also "Cu*")
copper (coated) 12-280
copper cylinders (supporting sample) 12-187, 12-190
copper disks 12-131, 12-135 12-237, 12-240, 12-243
copper foil (solder melted upon) 18-22, 18-25
copper shell 5-18

corundum (aluminum oxide) see also "Al*O*" 5-76, 5-79

Cu* (see also "copper") 5-18, 7-36, 10-28, 10-33, 12-131, 12-240, 12-243, 12-187, 12-190, 12-237, 12-280, 17-169, 18-22, 18-25
Au*<u>Cu*</u> 12-280

<u>D</u>

dextran 17-226

<u>F</u>

ferritic steel Thermax 4742 cartridge (see also "steel") 17-51

film (see also "coated materials," "coating," and "skin" (this index) and "Film" in the Key Words Index)
film (gold) 15-41
film (ceramic) 14-159

food can 8-3

free-surface elimination materials see "Free Surface Elimination" in the Key Words Index

fused quartz (see also "quartz," "glass," and "Si*O*") 7-24, 7-27, 10-3

fused silica (see also "silica," "glass," and "Si*O*") 8-38, 9-57, 9-67, 9-117, 9-129, 10-7, 10-12, 10-16, 10-20, 10-24, 12-167, 17-22
fused silica tube 5-113
fused silica with a platinum rhodium heater strip 12-267

G

glass (see also (1) "quartz," "fused quartz," "Pyrex™," "silica," "fused silica," and "Si*O*" (this index) and (2) "Glasses" in the Key Words Index)
1-3, 1-10, 1-22, 1-26, 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83, 1-86, 1-90, 2-24, 5-57, 7-33, 8-42, 9-109, 9-112, 9-138, 10-51, 10-68, 10-72, 11-55, 11-58, 12-3, 12-13, 12-105, 12-109, 12-115, 12-121, 12-123, 12-126, 12-284, 12-311, 12-316, 14-109, 14-137, 14-141, 15-4, 15-41, 15-44, 15-49, 16-18, 16-22, 16-31, 16-37, 16-42, 16-63, 17-199, 17-226
glass, borosilicate-type (see also "Pyrex™") 10-51
glass capillary 7-33
glass (cerodur, gold coated) 15-41
glass (coated) 12-105, 12-109, 12-284, 15-4, 15-41, 17-226
glass coated with polyfluorocarbon 12-284
glass cuvette 12-121
glass cuvettes (some possibly coated with dextran) 17-226
glass cylinders 12-13
glass fiber (see also the "Fiber..." titles in the Key Words Index) 1-86
glass hypodermic syringe 12-42
glass-like carbon (C*) 11-40
glass (optical) 12-118
glass (Pyrex™) see "Pyrex™"
glass (quartz) see "quartz"
glass (silica) see "silica"
glass (silicon-coated) 12-105, 12-109
glass/Teflon™ 1-86, 1-90
glass tubing (heat pipe) 18-156, 18-159
glass vials 16-25
glass with aluminum end plates 12-264

gold (see also "Au*")
gold coating 12-280, 15-41, 15-44, 15-49
gold-coated copper (Au*Cu*) 12-280
gold film on cerodur glass substrate 15-41

graphite (see also "C*" and "carbon") 4-11, 4-47, 4-51, 5-14, 5-18, 5-22, 5-26, 5-29, 5-33, 5-35, 5-41, 5-45, 5-48, 5-52, 5-104, 9-27, 9-31, 9-34, 9-51, 9-54, 11-9, 11-65, 11-70, 12-56, 12-139, 12-144, 12-149, 12-153, 12-157, 14-8, 14-29, 14-32, 14-35, 14-65, 14-128, 17-18, 17-92, 17-95, 17-99, 17-102, 17-116, 17-142, 17-181, 17-183, 17-187, 17-191, 17-196
graphite blocks 17-191
graphite (coated) 4-51, 9-27, 9-31
graphite (coating) 5-33, 5-35, 17-142
graphite (possibly) 5-45, 11-70, 17-187
graphite rods (used to create free surface zone) 12-139, 12-144, 12-149, 12-153, 12-157

H

highly reactive materials
see "Highly Reactive Materials" in the Key Words Index

hydrophobic coating (see also "coated materials" and "coating" (this index) and "Hydrophobic Surfaces" in the Key Words Index) 12-284

I

inert material 1-128, 1-140, 1-144, 1-148, 1-157, 1-161, 1-165, 1-170, 2-65, 8-99, 8-105, 11-91, 11-95, 16-65, 16-70

L

latex 16-22

Lexan^{TM} (a polycarbonate resin; see also "plastic") 1-6, 8-7, 8-12, 8-34, 12-53, 16-25, 17-178
Lexan^{TM} (electrophoresis separation chamber) 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83
Lexan^{TM} test tubes 2-6, 2-9

Lucite^{TM} block (see also "plastic") 16-25, 16-31, 16-37

M

magnesium (see "Mg*O*")

mesh screens (see also "screen") 2-3

metallic cartridge 17-142

metallic diaphram 17-142

Mg*O* powder "soft crucible" (see also the "Powder..." titles in the Key Words Index) 14-159

Mo* (see also "molybdenum") 4-24, 4-32, 5-14, 5-18, 5-90, 5-95, 11-13, 11-17, 17-59, 17-63, 17-72, 17-120, 17-128, 17-210, 18-77, 18-82, 18-105, 18-108
Mo*Ti*Zr* 4-32, 5-14, 18-77, 18-82
Mo*Ti*Zr*C* 4-24
Ta*Zr*Mo* 11-17

molybdenum (see also "Mo*," "TMZ" and "TZM")
molybdenum (plasma sprayed, skin material) 18-105, 18-108
molybdenum alloy TZM see "TZM"
molybdenum alloy with small amounts of titanium and zirconium (see also "TZM") 4-32, 5-14, 18-77, 18-82
tantalum-zirconium-molybdenum cartridge 11-17

N

N* (nitrogen) see also "boron nitride"
N*H* 18-86
Ti*N* 17-142
Si*N* 17-56

Ni* (nickel) 11-33, 11-37, 11-44, 12-260, 13-3, 15-53, 17-214, 17-222, 17-224
Ni*Al* 18-77
Ni* (polished) 12-260
Ni* with titanium oxide 18-102
Pt*Ni* 11-33, 11-37

nickel see "Ni*"

not applicable 3-3, 4-57, 6-3, 6-8, 6-13, 6-17, 6-21, 6-25, 6-28, 6-32, 6-35, 6-39, 6-44, 6-48, 6-52, 6-54, 6-57, 9-39, 9-84, 9-88, 9-91, 11-7, 12-27, 12-30, 12-34, 12-46, 12-50, 12-77, 12-79, 12-82, 12-86, 12-90, 12-93, 12-96, 12-98, 12-103, 12-178, 12-246, 12-249, 14-3, 14-120, 15-3, 15-5, 18-3, 18-55, 18-61, 18-64, 18-67, 18-71, 18-73, 18-129, 18-131, 18-135, 18-228, 18-231, 18-247

P

PerspexTM (see also "PlexiglasTM" and "plastic") 1-105, 1-108, 1-111, 1-125, 12-229, 12-233

plasma-spray (see also "coating" (this index) and "Plasma Spray Coating" and "Coated Surfaces" in the Key Words Index)
plasma-sprayed alumina 14-97, 18-77, 18-82, 18-116
plasma-sprayed molybdenum 18-105, 18-108
plasma-sprayed Zr*O*Y*O* 18-111

plastic (see also "LexanTM," "LuciteTM," "PerspexTM," "PlexiglasTM," "polyacetal," "polypropylene," "PVC," "TeflonTM," and "TygonTM") 1-95, 8-7, 8-95, 11-3, 12-22, 12-256, 12-294, 15-72, 17-14
plastic (acrylic) 8-95, 12-256
plastic (insulating, low wettability) 12-13
plastic (optically-clear) 12-7
plastic (polycarbonate, specific trademark unidentified) 17-14

plasticized/unplasticized
polymer/<u>plasticized</u> formulations 1-121
polyolefin (<u>unplasticized</u>) 1-121
polyvinylchloride <u>plasticized</u> with di-(2-ethylhexyl) phthalate (PVC--DEHP) 1-121
polyvinylchloride <u>plasticized</u> with trioctyltrimellitate (PVC-TOTM) 1-121

platinum (see also "Pt*")
platinum jacket 11-17
platinum-rhodium alloy (electrode) in contact with solution, 7-17, 7-21
platinum-rhodium heater strip 12-167
platinum wire 15-32, 15-36

PlexiglasTM (see also "PerspexTM" and "plastic") 1-17, 1-125, 1-101, 1-108, 1-125, 8-55, 8-58, 8-95, 9-45, 9-48, 12-252, 12-256, 14-19, 14-23, 14-26, 15-26, 15-81, 16-12, 17-199, 18-212, 18-252

polyacetal (see also "plastic") 14-137, 14-141

polycarbonate see "plastic"

polyfluorocarbon (TeflonTM-type) 12-284

polymer/plasticized formulations 1-121

polyolefin (unplasticized) 1-121

polypropylene (see also "plastic") 16-25
polypropylene reservoir 1-57, 1-61, 1-65

polytetrafluoroethylene coating (PTFE Teflon™) 15-10, 15-13, 15-16, 15-19

polyurethane foam (lining GAS can interior) 18-241

polyvinylchloride (see also "plastic," "PVC" and "vinyl")
polyvinylchloride plasticized with di-(2-ethylhexyl) phthalate (PVC-DEHP) 1-121
polyvinylchloride plasticized with trioctyltrimellitate (PVC-TOTM) 1-121

Pt* (platinum) 11-13, 11-17, 11-21, 11-24, 11-28, 11-33, 11-37, 11-44, 11-48, 11-50, 11-52, 15-32, 15-36
Pt*Ni* 11-33, 11-37

PTFE (polytetrafluoroethylene) Teflon™ coating 15-10, 15-13, 15-16, 15-19

PVC (see also "polyvinylchloride," "plastic," and "vinyl") 14-137
PVC plasticized with di-(2-ethylhexyl) phthalate (PVC-DEHP) 1-121
PVC plasticized with trioctyltrimellitate (PVC-TOTM) 1-121

Pyrex™ (see also "glass") 1-29, 9-101, 9-106, 9-112, 9-138, 10-51, 10-57, 10-62, 12-60, 12-65, 12-194, 12-198, 14-167
Pyrex™ glass tube (filled with argon) 9-112
Pyrex™ tubes (coated) 1-29

pyrolytic boron nitride (see also "boron nitride") 17-22

Q

quartz (see also "fused quartz" "glass," and "Si*O*") 4-9, 4-13, 4-44, 5-62, 5-66, 7-24, 7-27, 8-22, 8-24, 8-38, 8-42, 8-45, 8-52, 8-84, 9-5, 9-9, 9-14, 9-76, 9-101, 9-106, 9-109, 9-144, 9-156, 10-3, 10-38, 10-43, 10-65, 11-55, 11-58, 12-162, 14-26, 14-112, 14-128, 14-131, 14-134, 17-6, 17-11, 17-22, 17-30, 17-133, 17-136, 17-175
quartz (graphitized) 8-88
quartz windows 12-289

R

resin (see "Lexan™ (polycarbonate resin)")

rubber 8-48

S

safety wire 12-40

sapphire
sapphire (synthetic) 7-17, 7-21
sapphire (transparent) 12-260
sapphire windows (possibly) 7-36

screen
screen (mesh) 2-3
screen (stainless steel) 12-256
screen (twill) 2-3

Si* (see also "silicon," "silica," "Si*O*" and "quartz")
Si* 12-105, 12-109
Si*C* 4-51, 17-139
Si*N* 17-56

silica (see also "fused silica," "glass," and "Si*O*") 4-3, 8-38, 9-19, 9-41, 9-57, 9-67, 9-95, 9-117, 9-129, 9-134, 9-149, 9-153, 10-7, 10-12, 10-16, 10-20, 10-24, 10-68, 17-22
boro<u>silica</u>te glass 10-51
silica (carbon coated) 9-19
silica coating 9-117
silica tube 5-41, 5-45, 5-113

silicon (see also "Si*")
silicon carbide 17-139
silicon carbide layer deposited on graphite 4-51
silicon-coated glass 12-105, 12-109

sintered corundum (aluminum oxide) see also "Al*O*" 5-76, 5-79

Si*O* (see also "Si*" (above), "silica," "quartz," and "glass") 4-3, 4-9, 4-13, 4-44, 5-41, 5-45, 5-62, 5-66, 5-113, 7-24, 7-27, 8-22, 8-24, 8-38, 8-42, 8-45, 8-52, 8-84, 8-88, 9-5, 9-9, 9-14, 9-19, 9-41, 9-57, 9-67, 9-76, 9-101, 9-109, 9-117, 9-129, 9-134, 9-144, 9-149, 9-153, 9-156, 10-3, 10-7, 10-12, 10-16, 10-20, 10-24, 10-38, 10-43, 10-65, 10-68, 11-55, 11-58, 12-162, 12-167, 14-26, 14-112, 14-128, 14-131, 14-134, 17-6, 17-11, 17-22, 17-30, 17-133, 17-136, 17-175

skin (see also "coating" (this index) and the "Skin..." titles in the Key Words Index)
skin (alumina) 5-76, 5-79, 18-116
skin (ammonium-tartrate) 18-86
skin (molybdenum) 18-105, 18-108
skin (titanium oxide with nickel) 18-102
skin (Zr*O*Y*O*) 18-111

Sn*O* (tin oxide) 18-89, 18-92

stainless steel (see also "steel") 4-11, 5-33, 5-35, 5-45, 5-90, 5-95, 7-11, 8-17, 9-5, 9-9, 9-14, 9-34, 10-57, 10-62, 11-55, 11-58, 11-74, 12-56, 12-194, 12-198, 12-213, 13-21, 14-38, 14-42, 14-61, 14-137, 14-141, 17-6, 17-11, 17-59, 17-63, 17-69, 17-102, 17-110, 17-217, 18-8, 18-144, 18-189, 18-195, 18-199, 18-203, 18-207
stainless steel (AISI 321) 14-38, 14-42
stainless steel cartridge 4-3, 4-38, 4-41, 5-41, 9-27, 9-31, 17-18, 17-34, 17-38, 17-43
stainless steel cells (Teflon™-coated) 8-63, 8-67, 15-10, 15-13, 15-16, 15-19
stainless steel (coated) 8-63, 8-67, 15-10, 15-13, 15-16, 15-19
stainless steel (coated with PTFE (PTFE Teflon™)) 15-10, 15-13, 15-16, 15-19
stainless steel disks 2-28
stainless steel endcaps 7-17, 7-21
stainless steel reactors (Teflon™-coated) 8-63

stainless steel screen
12-256

steel (see also "stainless steel") 10-72, 12-56, 14-159, 17-51, 17-72
steel cartridge (He-filled)
14-159
steel (ferritic) 17-51
steel (top of shutter)
12-109, 12-115

surfactants see "Surfactants" in the Key Words Index

T

Ta* (Tantalum) 5-22, 5-82, 5-140, 9-73, 9-79, 9-81, 11-9, 17-191, 17-196
Ta*Zr*Mo* 11-17

tantalum-zirconium-molybdenum cartridge 11-17

Teflon™ (see also "plastic") 1-135, 1-152, 2-13, 8-17, 8-67, 12-175, 12-311, 12-316, 17-159, 17-163
Teflon™-coated aluminum
8-3, 8-30
Teflon™-coated release
paper 5-109
Teflon™-coated, stainless
steel 8-63, 8-67
Teflon™ (coating) 12-307
Teflon™/glass 1-90
Teflon™/glass fiber 1-86
Teflon™ PTFE (polytetra-
fluoroethylene) coating
15-10, 15-13, 15-16, 15-19
Teflon™ shutter
12-105, 12-109, 12-115
Teflon™ sliding plate
8-67
Teflon™-type polyfluoro-
carbon 12-284

tetrafluoroethylene (see "Teflon™")

Ti* (listed as the primary element) see also "titanium" 2-37, 2-41
Ti*N* 17-142
Ti*N* coating 17-142
Ti*O* 18-102

Ti* (listed as a secondary element) see also "titanium"
Mo*Ti*Zr* 4-32, 5-14,
18-77, 18-82
Mo*Ti*Zr*C* 4-24

tin oxide coating (Sn*O*) 18-89, 18-92

titanium (see also "Ti*")
titanium oxide Ti*O*, with
nickel (skin material)
18-102

TMZ (see also "Mo*" and "TZM") 4-97, 15-18, 18-77, 18-82
TMZ-molybdenum alloy 5-14

transparent material (specific material unspecified) see also "plastics" 12-38

twill screens (see also "screen") 2-3

Tygon™ tubes (see also "plastic") 1-43, 1-48, 1-53, 1-57, 1-61, 1-65, 1-69, 1-73, 1-83

TZM (see also "Mo*" and "TMZ") 4-24, 4-32, 5-18, 5-26, 11-17, 13-11, 17-59, 17-63, 17-120, 17-128, 17-210

<u>**U**</u>

unclear/unknown/unspecified 1-14, 1-35, 1-41, 1-78, 1-105, 1-108, 1-111, 1-113, 1-118, 2-3, 2-16, 2-19, 2-21, 2-26, 2-46, 2-49, 2-62, 4-16, 4-19, 4-22, 4-55, 5-39, 5-45, 5-69, 5-85, 5-87, 5-116, 5-118, 5-130, 5-132, 7-3, 7-5, 7-8, 7-31, 7-36, 8-27, 8-74, 8-81, 8-92, 8-99, 9-3, 9-61, 9-63, 9-65, 9-69, 9-98, 9-104, 9-121, 10-38, 11-58, 11-70, 11-79, 11-86, 11-89, 12-13, 12-18, 12-24, 12-26, 12-53, 12-113, 12-121, 12-123, 12-126, 12-129, 12-181, 12-201, 12-206, 12-209, 12-211, 12-226, 12-275, 12-298, 12-305, 12-307, 12-321, 13-14, 13-16, 14-15, 14-49, 14-52, 14-55, 14-57, 14-59, 14-73, 14-76, 14-78, 14-80, 14-82, 14-85, 14-89, 14-114, 14-116, 14-124, 14-126, 14-145, 14-148, 14-150, 15-5, 15-22, 15-24, 15-30, 15-32, 15-36, 15-39, 15-41, 15-44, 15-49, 15-60, 15-63, 15-66, 15-69, 15-76, 15-78, 16-3, 16-5, 16-8, 16-10, 16-15, 16-42, 16-48, 16-53, 16-58, 16-63, 17-3, 17-26, 17-48, 17-66, 17-80, 17-82, 17-86, 17-88, 17-90, 17-105, 17-107, 17-113, 17-125, 17-169, 17-172, 17-178, 17-187, 18-15, 18-19, 18-28, 18-58, 18-95, 18-97, 18-116, 18-121, 18-123, 18-125, 18-127, 18-144, 18-149, 18-153, 18-162, 18-166, 18-169, 18-173, 18-178, 18-184, 18-215, 18-234, 18-244, 18-250

unplasticized polyolefin (see also "plasticized") 1-121

<u>**V**</u>

vinyl (see also "PVC") 1-43, 1-48, 1-53, 1-69, 1-73, 1-83

<u>**W**</u>

wettability (see also "Coated Surfaces," "Crucible Effects," "Free Surface Elimination," "Hydrophobic Surfaces," "Liquid Spreading," "Material Interaction with Containment Facility," "Non-wetting of Container," "Sample Detachment from Crucible," and "Wetting" in the Key Words Index)
anti-wetting coating 12-284
high wettability aluminum 12-13
low wettability, insulating plastic 12-13

wire
wire (platinum) 15-32, 15-36
wire (safety) 12-40

<u>**Z**</u>

zirconium (see also "Zr*")
molybdenum alloy with small amounts of titanium and <u>zirconium</u> 4-32, 5-14, 18-77, 18-82
zirconium-tantalum-molybdenum cartridge 11-17

Zr* (see also "zirconium") 11-82, 11-62
Mo*Ti*Zr* 4-32, 5-14, 18-77, 18-82
Mo*Ti*Zr*C* 4-24
Ta*Zr*Mo* 11-17
Zr*O* 14-93
Zr*O*Y*O* (plasma-sprayed skin) 18-111

Index G: Mission

Mission Index

Mercury-Aurora 7 (1962)
12-3

Apollo (1971-1972)

Early Apollo (Planned)
9-3
Apollo 14 (1971)
1-3, 5-3, 5-7, 5-10, 12-7, 12-13, 17-3
Apollo 16 (1972)
1-6
Apollo 17 (1972)
12-18

Skylab (1973-1974)

Skylab (Planned)
1-14, 12-22, 15-3
SL-2, First Manned Mission
6-3, 10-3, 14-3, 18-3
SL-3, Second Manned Mission
4-3, 5-41, 6-8, 9-5, 9-19, 9-27, 9-34, 10-7, 11-3, 11-9, 12-24, 12-27, 14-8, 15-5, 17-6, 18-61
SL-4, Third Manned Mission
1-17, 2-3, 3-3, 5-45, 6-13, 8-3, 8-7, 9-9, 9-25, 9-39, 10-12, 11-7, 12-30, 12-34, 12-38, 12-40, 12-42, 12-46, 12-50, 14-11, 17-11, 17-14

Apollo-Soyuz Test Project (ASTP) (1975)
1-29, 1-35, 2-6, 2-9, 2-13, 8-12, 9-14, 9-31, 10-16, 12-53, 12-56, 17-18, 17-22

SPAR (United States Sounding Rocket) (1975-1983)

SPAR 1 (1975)
4-9, 5-48, 5-57, 9-41, 12-60, 12-71, 14-15, 14-19, 14-38
SPAR 2 (1976)
4-13, 5-52, 14-23, 14-42, 17-34, 17-51
SPAR 3 (1976)
6-17, 9-51, 12-65, 12-74, 12-77
SPAR 4 (1977)
5-62, 6-21, 9-45, 12-79
SPAR 5 (1978)
5-66, 9-48, 14-26, 17-38
SPAR 6 (1979)
6-28, 9-54, 12-82, 17-133
SPAR 7 (1980)
12-86, 12-90, 14-29
SPAR 8 (1980)
6-32, 12-93, 12-167
SPAR 9 (1981)
4-22, 14-32, 17-136, 17-139
SPAR 10 (1983) 4-24, 12-96, 14-35, 17-175

TEXUS (German Sounding Rocket)
(1977-1988) <Note: This TM documents TEXUS missions up to 1988.>

TEXUS 1 (1977)
5-69, 5-90, 6-25, 11-13, 12-105, 14-46, 14-49, 15-10, 15-22, 17-56, 17-59, 18-64, 18-77
TEXUS 2 (1978)
2-16, 5-72, 5-95, 12-109, 14-52, 14-69, 14-76, 14-78, 14-80, 15-26, 17-63, 17-80, 17-82, 17-86, 17-120, 18-8, 18-82
TEXUS 3 (1980)
2-19, 4-16, 5-76, 12-113, 12-129, 12-139, 15-30, 16-3, 17-66, 17-88, 18-86, 18-125

TEXUS 3b (1981)
2-21, 4-19, 5-79, 12-115, 12-131, 12-144, 15-32, 16-5, 17-69, 17-90, 18-89, 18-127
TEXUS 4 (1981)
4-27, 4-29, 9-69, 11-17, 12-218, 14-82, 15-13, 16-8, 18-92
TEXUS 5 (1982)
2-24, 4-38, 5-82, 12-149, 14-73, 15-36, 16-10, 17-72, 17-92, 17-95, 17-142, 18-19, 18-95
TEXUS 6 (1982)
4-32, 5-14, 7-3, 9-73, 11-21, 12-121, 14-85, 14-97, 15-24
TEXUS 7 (1983)
4-35, 5-18, 9-76, 9-79, 12-135, 14-55, 14-114, 15-16, 17-75, 17-99, 17-146, 17-169, 18-97
TEXUS 8 (1983)
7-5, 7-8, 11-55, 12-123, 12-153, 12-194, 13-3, 15-39, 17-149
TEXUS 9 (1984)
4-41, 5-26, 5-87, 6-48, 12-198, 12-237, 15-19, 17-152, 18-67, 18-102
TEXUS 10 (1984)
2-26, 2-52, 5-118, 7-17, 9-98, 13-6, 14-59, 14-131, 14-137, 15-41
TEXUS 11 (1985)
1-105, 5-121, 7-24, 11-33, 12-126, 15-44, 18-105
TEXUS 12 (1985)
2-54, 5-124, 5-130, 7-21, 9-81, 9-101, 9-117, 11-37, 13-11, 17-102, 18-108
TEXUS 13 (1986)
1-108, 7-27, 8-92, 11-44, 12-206, 15-49, 17-210, 17-214
TEXUS 14a (1986)
1-111, 5-33, 5-132, 6-52, 9-104, 12-240, 15-63, 17-105, 18-71
TEXUS 14b (1987)
1-113, 5-35, 5-135, 6-54, 9-106, 12-243, 15-66, 17-110, 18-73
TEXUS 15 (1987)
9-149, 11-48, 12-209, 13-14, 15-76, 17-222, 18-121
TEXUS 16 (1987)
5-39, 9-153, 11-50, 11-52, 11-89, 12-211, 13-16, 13-18, 17-224, 18-123
TEXUS 17 (1988)
1-125, 7-36, 15-69, 15-78
TEXUS 18 (1988)
1-41, 1-118, 2-58

TT-500A (Japanese Sounding Rocket) (1980-1983)

TT-500A 8 (1980)
5-99, 9-57
TT-500A 9 (1981)
5-104, 9-61
TT-500A 10 (1981)
8-22, 9-63
TT-500A 11 (1982)
5-106, 9-65
TT-500A 12 (1983)
8-24, 9-67, 18-129
TT-500A 13 (1983)
5-113, 5-116, 17-181

Space Transportation System (STS) Space Shuttle (1982-1990)
<Note: This TM documents STS missions up to 1990.>

STS-3/STS OFT-3 (1982)
1-10, 18-139, 18-189
STS-4/STS OFT-4 (1982)
1-43, 5-109, 12-172, 14-105, 17-155, 18-22, 18-195
STS-5/STS 31-A (1982)
8-27, 12-175, 12-184, 17-159
STS-6/STS 31-B (1983)
1-48, 4-44, 10-28, 14-109, 14-112, 18-28, 18-199, 18-212

STS-7/STS 31-C (1983)
1-53, 6-35, 8-30, 10-20, 12-157, 12-213, 14-116, 15-53, 17-43, 17-125, 17-163, 17-178, 18-31, 18-34, 18-37, 18-40, 18-43, 18-46, 18-49, 18-52, 18-55, 18-144, 18-203
STS-8/STS 31-D (1983)
1-69, 1-73, 1-78, 1-83, 10-33, 18-149
STS-9/STS 41-A (1983)
12-178
STS 41-B (1984)
1-22, 2-46, 6-44, 11-28, 12-187, 15-57, 16-18, 18-25, 18-131, 18-156, 18-207, 18-220, 18-228
STS 41-C (1984/1990)
8-17, 18-162, 18-166, 18-169
STS 41-D (1984)
1-57, 9-112, 16-22
STS 41-G (1984)
2-49, 8-55, 10-46, 12-190, 12-246, 12-252, 14-145, 14-150, 18-58, 18-135, 18-159, 18-234, 18-238
STS 51-A (1984)
8-63
STS 51-C (1985)
12-256
STS 51-D (1985)
1-61, 1-95, 12-249, 14-148, 16-25, 18-173
STS 51-G (1985) 2-62, 7-31, 8-81, 12-264, 17-26, 17-128, 17-199, 18-178, 18-224, 18-244, 18-247
STS 51-I (1985)
10-57
STS 61-B (1985)
1-65, 8-67, 9-138, 10-72, 16-37
STS 61-C (1986)
1-121, 4-55, 6-57, 8-58, 12-103, 12-298, 12-301, 12-305, 14-153, 14-163, 15-60, 16-42, 18-184, 18-241, 18-250, 18-252
STS-26 (1988)
1-26, 1-101, 8-95, 10-62, 14-167, 16-48, 17-30
STS-29 (1989)
16-53, 18-153
STS-32 (1990)
16-58
STS Spacelab 1 (1983)
1-86, 2-28, 2-37, 4-47, 4-51, 5-22, 5-85, 5-140, 8-34, 8-38, 8-48, 8-52, 9-84, 9-91, 9-95, 10-38, 11-24, 11-62, 11-65, 12-181, 12-217, 12-226, 12-229, 14-57, 14-89, 14-100, 14-120, 14-124, 14-128, 16-12, 17-172, 17-183, 17-191, 18-12, 18-99, 18-215
STS Spacelab 2 (1985)
12-271, 12-275, 16-31
STS Spacelab 3 (1985)
8-74, 10-43, 10-51, 12-98, 12-260
STS Spacelab D1 (1985)
1-90, 2-33, 2-41, 5-29, 5-126, 6-39, 7-11, 7-33, 8-42, 8-45, 8-84, 8-88, 9-88, 9-121, 9-125, 9-129, 9-134, 10-24, 10-65, 10-68, 11-40, 11-70, 11-74, 11-79, 11-82, 11-86, 12-162, 12-201, 12-222, 12-233, 12-280, 12-284, 12-289, 12-294, 14-93, 14-134, 14-136, 14-141, 14-159, 16-15, 16-63, 17-48, 17-187, 17-196, 17-205, 18-111, 18-116

MASER (Swedish Sounding Rocket)
(1987-1988) <Note: This TM documents MASER missions up to 1988.>

MASER 1 (1987)
9-144, 12-307, 12-311, 14-61, 15-72, 17-107, 17-217
MASER 2 (1988)
9-109, 9-156, 12-316, 12-321, 14-65, 17-113, 17-116, 18-15

☆ U.S. GOVERNMENT PRINTING OFFICE—1997—532-128/60001

Consort 1 (United States Sounding Rocket) (1989)
1-128, 1-135, 1-140, 1-148, 1-152, 1-157, 1-161, 1-165, 1-170, 2-65, 4-57, 8-99, 8-105, 11-91, 11-95, 13-21, 15-81, 16-65, 16-70, 17-226, 17-230, 18-231

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave Blank)

2. REPORT DATE
November 1996

3. REPORT TYPE AND DATES COVERED
Technical Memorandum

4. TITLE AND SUBTITLE

The Microgravity Research Experiments (MICREX) Data Base

5. FUNDING NUMBERS

6. AUTHOR(S)

C.A. Winter and J.C. Jones*

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

8. PERFORMING ORGANIZATON REPORT NUMBERS
TM-108523
Volume I

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Prepared by Space Sciences Laboratory, Science and Engineering Directorate
*University of Alabama in Huntsville (UAH)

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified - Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

An electronic data base identifying over 800 fluids and materials processing experiments performed in a low-gravity environment has been created at NASA Marshall Space Flight Center. The compilation, called MICREX (MICrogravity Research Experiments), was designed to document all such experimental efforts performed (1) on U.S. manned space vehicles, (2) on payloads deployed from U.S. manned space vehicles, and (3) on all domestic and international sounding rockets (excluding those of China and the former U.S.S.R.). Data available on most experiments include (1) principal and co-investigators, (2) low-gravity mission, (3) processing facility, (4) experimental objectives and results, (5) identifying key words, (6) sample materials, (7) applications of the processed materials/research area, (8) experiment descriptive publications, and (9) contacts for more information concerning the experiment. This technical memorandum (1) summarizes the historical interest in reduced-gravity fluid dynamics, (2) describes the experimental facilities employed to examine reduced gravity fluid flow, (3) discusses the importance of a low-gravity fluids and materials processing data base, (4) describes the MICREX data base format and computational World Wide Web access procedures, and (5) documents (in hard-copy form) the descriptions of the first 600 fluids and materials processing experiments entered into MICREX.

14. SUBJECT TERMS data base, low-gravity materials processing, fluid dynamic experiments, low-g facilities, early rocket design, aircraft low-g test-beds, drop tubes, drop towers, sounding rockets, Apollo program, Skylab, space shuttle, low-g experiment history

15. NUMBER OF PAGES
377

16. PRICE CODE
NTIS

17. SECURITY CLASSIFICATION	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited